

# NANDHA ENGINEERING COLLEGE

(An Autonomous Institution affiliated to Anna University Chennai and approved by AICTE, New Delhi)  
Erode-638 052, Tamil Nadu, India, Phone: 04294 – 225585



**Curriculum and Syllabi**

**for**

**B.E. – Mechanical Engineering [R22]**

**[CHOICE BASED CREDIT SYSTEM]**

(This Curriculum and Syllabi are applicable to the Students admitted from 2024 onwards)

**APRIL 2025**

| <b>INSTITUTE VISION AND MISSION</b> |                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>VISION</b>                       | <ul style="list-style-type: none"> <li>• To be an Institute of excellence providing quality Engineering, Technology and Management education to meet the ever changing needs of the society.</li> </ul>                                                                                                                                                                                           |
| <b>MISSION</b>                      | <ul style="list-style-type: none"> <li>• To provide quality education to produce ethical and competent professionals with social Responsibility</li> <li>• To excel in the thrust areas of Engineering, Technology and Entrepreneurship by solving real- world problems.</li> <li>• To create a learner centric environment and improve continually to meet the changing global needs.</li> </ul> |

| <b>B.E. – MECHANICAL ENGINEERING</b>          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>VISION</b>                                 | <ul style="list-style-type: none"> <li>• To be recognised as a centre of excellence in the field of Mechanical Engineering and to produce competent engineers with multi-disciplinary exposure to meet the changing needs of the society.</li> </ul>                                                                                                                                                                                                                                                                                                                       |
| <b>MISSION</b>                                | <ul style="list-style-type: none"> <li>• To enrich technical knowledge and skills by imparting quality education with ethics and social responsibility.</li> <li>• To empower the students in the thrust areas of Mechanical, Allied Engineering and Entrepreneurship in the continually changing global market.</li> <li>• To provide a conducive learning environment for improving continually to cater the needs of the society.</li> </ul>                                                                                                                            |
| <b>PROGRAMME EDUCATIONAL OBJECTIVES (PEO)</b> | <p><b>The graduates of Mechanical Engineering will be</b></p> <p><b>PEO1: Core Competency:</b> A Successful professional with core competency and inter-disciplinary skills to satisfy the Industrial needs.</p> <p><b>PEO2: Research, Innovation and Entrepreneurship:</b> Capable of identifying technological requirements for the society and providing innovative solutions to real time problems.</p> <p><b>PEO3: Ethics, Human values and Life-long learning:</b> able to apply professional and ethical practices in their career through continuous learning.</p> |
| <b>PROGRAMME SPECIFIC OUTCOMES (PSO)</b>      | <p><b>The students of Mechanical Engineering will be able to</b></p> <ul style="list-style-type: none"> <li>• Identify, formulate and analyze the problems of Mechanical, Allied Engineering systems and product development.</li> <li>• Apply appropriate computer aided engineering tools for modeling, simulation, analysis, and manufacturing techniques to solve engineering problems.</li> </ul>                                                                                                                                                                     |

## PROGRAM OUTCOMES:

At the end of this programme the students will be able to

| GRADUATE ATTRIBUTES                        | PO No. | PROGRAMME OUTCOMES                                                                                                                                                                                                                                                                |
|--------------------------------------------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Engineering Knowledge                      | PO1    | Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.                                                        |
| Problem Analysis                           | PO2    | Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)                                                                                          |
| Design / Development of Solutions          | PO3    | 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) |
| Conduct Investigations of Complex Problems | PO4    | Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)                                                                           |
| Engineering Tool Usage                     | PO5    | 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)                                                               |
| The Engineer and The World                 | PO6    | 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)                                      |
| Ethics                                     | PO7    | Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)                                                                                                                                 |
| Individual and Collaborative Team work     | PO8    | Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.                                                                                                                                                                             |
| Communication                              | PO9    | 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.      |
| Project Management and Finance             | PO10   | 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.                                            |
| Life-Long Learning                         | PO11   | 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)                                        |

## MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the Programme Educational Objectives and the outcomes is given in the following table

| PROGRAMME EDUCATIONAL OBJECTIVES | PROGRAMME OUTCOMES |   |   |   |   |   |   |   |   |    |    |
|----------------------------------|--------------------|---|---|---|---|---|---|---|---|----|----|
|                                  | 1                  | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1                                | 3                  | 3 | 2 | 3 | 2 | 1 | 2 | 1 | 2 | 2  | 3  |
| 2                                | 3                  | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 | 2  | 3  |
| 3                                | 3                  | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 2 | 2  | 3  |

**Contribution**

**1: Reasonable**

**2: Significant**

**3: Strong**

## MAPPING OF PROGRAM SPECIFIC OUTCOMES WITH PROGRAMME OUTCOMES

A broad relation between the Program Specific Objectives and the outcomes is given in the following table

| PROGRAM SPECIFIC OUTCOMES | PROGRAMME OUTCOMES |   |   |   |   |   |   |   |   |    |    |
|---------------------------|--------------------|---|---|---|---|---|---|---|---|----|----|
|                           | 1                  | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1                         | 3                  | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1  | 2  |
| 2                         | 3                  | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 3 | 3  | 3  |

**Contribution**

**1: Reasonable**

**2: Significant**

**3: Strong**

| SEMESTER: I                  |             |                                                  |          |               |                 |           |          |           |           |
|------------------------------|-------------|--------------------------------------------------|----------|---------------|-----------------|-----------|----------|-----------|-----------|
| S. NO.                       | COURSE CODE | COURSE TITLE                                     | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L         | T        | P         | C         |
| 1                            | 22MAN01     | Induction Programme                              | MC       | -             | -               | -         | -        | -         | -         |
| <b>THEORY</b>                |             |                                                  |          |               |                 |           |          |           |           |
| 2                            | 22EYA01     | Professional Communication - I                   | HSMC     | -             | 4               | 2         | 0        | 2         | 3         |
| 3                            | 22MYB01     | Calculus and Linear Algebra*                     | BSC      | -             | 4               | 3         | 1        | 0         | 4         |
| 4                            | 22CYB02     | Chemistry for Engineers                          | BSC      | -             | 3               | 3         | 0        | 0         | 3         |
| 5                            | 22EEC02     | Basic Electrical Engineering                     | ESC      | -             | 3               | 3         | 0        | 0         | 3         |
| 6                            | 22MEC02     | Engineering Graphics and drafting (Theory + Lab) | ESC      | -             | 5               | 3         | 0        | 2         | 4         |
| 7                            | 22GYA01     | தமிழர் மரபு /Heritage of Tamils                  | HSMC     | -             | 1               | 1         | 0        | 0         | 1         |
| <b>PRACTICAL</b>             |             |                                                  |          |               |                 |           |          |           |           |
| 8                            | 22GEP01     | Engineering Practices Laboratory                 | ESC      | -             | 4               | 0         | 0        | 4         | 2         |
| 9                            | 22CYP01     | Chemistry Laboratory*                            | BSC      | -             | 2               | 0         | 0        | 2         | 1         |
| Mandatory Non Credit Courses |             |                                                  |          |               |                 |           |          |           |           |
| 10                           | 22MAN03     | Yoga – I*                                        | MC       | -             | 1               | 0         | 0        | 1         | 0         |
| <b>TOTAL</b>                 |             |                                                  |          |               | <b>27</b>       | <b>15</b> | <b>1</b> | <b>11</b> | <b>21</b> |

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| SEMESTER: II                        |             |                                                          |          |               |                 |           |          |           |           |
|-------------------------------------|-------------|----------------------------------------------------------|----------|---------------|-----------------|-----------|----------|-----------|-----------|
| S. NO                               | COURSE CODE | COURSE TITLE                                             | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L         | T        | P         | C         |
| <b>THEORY</b>                       |             |                                                          |          |               |                 |           |          |           |           |
| 1                                   | 22EYA02     | Professional Communication - II                          | HSMC     | 22EYA01       | 4               | 2         | 0        | 2         | 3         |
| 2                                   | 22MYB02     | Partial Differential Equations and Transform Techniques* | BSC      | -             | 4               | 3         | 1        | 0         | 4         |
| 3                                   | 22PYB04     | Physics for Mechanical Engineering                       | BSC      | -             | 3               | 3         | 0        | 0         | 3         |
| 4                                   | 22CSC01     | Problem Solving and C Programming*                       | ESC      | -             | 3               | 3         | 0        | 0         | 3         |
| 5                                   | 22ECC03     | Basics of Electronics and instrumentation Engineering    | ESC      | -             | 3               | 3         | 0        | 0         | 3         |
| 6                                   | 22MEC03     | Engineering Mechanics                                    | ESC      | -             | 3               | 2         | 1        | 0         | 3         |
| 7                                   | 22GYA02     | தமிழரும் தொழில்நுட்பமும் /Tamil and Technology           | HSMC     | -             | 1               | 1         | 0        | 0         | 1         |
| <b>PRACTICAL</b>                    |             |                                                          |          |               |                 |           |          |           |           |
| 8                                   | 22CSP01     | Problem Solving and C Programming Laboratory*            | ESC      | -             | 4               | 0         | 0        | 4         | 2         |
| 9                                   | 22PYP01     | Physics Laboratory*                                      | BSC      | -             | 2               | 0         | 0        | 2         | 1         |
| <b>Mandatory Non Credit Courses</b> |             |                                                          |          |               |                 |           |          |           |           |
| 10                                  | 22MAN02R    | Soft / Analytical Skills – I <sup>##</sup>               | MC       | -             | 3               | 1         | 0        | 2         | 0         |
| 11                                  | 22MAN05     | Yoga – II*                                               | MC       | -             | 1               | 0         | 0        | 1         | 0         |
| <b>TOTAL</b>                        |             |                                                          |          |               | <b>31</b>       | <b>18</b> | <b>2</b> | <b>11</b> | <b>23</b> |

\* Ratified by Eleventh Academic Council

| SEMESTER: III                       |             |                                              |          |               |                 |           |          |          |           |
|-------------------------------------|-------------|----------------------------------------------|----------|---------------|-----------------|-----------|----------|----------|-----------|
| S. NO.                              | COURSE CODE | COURSE TITLE                                 | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L         | T        | P        | C         |
| <b>THEORY</b>                       |             |                                              |          |               |                 |           |          |          |           |
| 1                                   | 22MYB03     | Statistics and Numerical Methods             | BSC      | -             | 4               | 3         | 1        | 0        | 4         |
| 2                                   | 22MEC04     | Engineering Thermodynamics                   | PCC      | -             | 3               | 2         | 1        | 0        | 3         |
| 3                                   | 22MEC05     | Fluid Mechanics and Machinery (Theory + Lab) | ESC      | -             | 5               | 3         | 0        | 2        | 4         |
| 4                                   | 22MEC06     | Manufacturing Processes                      | PCC      | -             | 3               | 3         | 0        | 0        | 3         |
| 5                                   | 22MEC07     | Engineering Materials and Metallurgy         | PCC      | -             | 3               | 3         | 0        | 0        | 3         |
| <b>PRACTICAL</b>                    |             |                                              |          |               |                 |           |          |          |           |
| 6                                   | 22MEP02     | Computer Aided Machine Drawing               | ESC      | -             | 4               | 0         | 0        | 4        | 2         |
| <b>Mandatory Non Credit Courses</b> |             |                                              |          |               |                 |           |          |          |           |
| 7                                   | 22MAN04R    | Soft / Analytical Skills – II##              | MC       | 22MAN02R      | 3               | 1         | 0        | 2        | 0         |
| 8                                   | 22MAN09     | Indian Constitution                          | MC       | -             | 1               | 1         | 0        | 0        | 0         |
| <b>TOTAL</b>                        |             |                                              |          |               | <b>26</b>       | <b>16</b> | <b>2</b> | <b>8</b> | <b>19</b> |

| SEMESTER: IV                        |             |                                                |           |               |                 |    |   |    |    |
|-------------------------------------|-------------|------------------------------------------------|-----------|---------------|-----------------|----|---|----|----|
| S. NO.                              | COURSE CODE | COURSE TITLE                                   | CATEGORY  | PRE-REQUISITE | CONTACT PERIODS | L  | T | P  | C  |
| <b>THEORY</b>                       |             |                                                |           |               |                 |    |   |    |    |
| 1                                   | 22MEC09     | Thermal Engineering Systems                    | PCC       | 22MEC04       | 4               | 3  | 1 | 0  | 4  |
| 2                                   | 22MEC10     | Subtractive Manufacturing Processes            | PCC       | 22MEC06       | 3               | 3  | 0 | 0  | 3  |
| 3                                   | 22MEC11     | Strength of Materials (Theory + Lab)           | PCC       | -             | 5               | 3  | 0 | 2  | 4  |
| 4                                   | 22MEC12     | Theory of Machines (Theory + Lab)              | PCC       | -             | 5               | 3  | 0 | 2  | 4  |
| 5                                   | EI          | Elective (OEC/PEC)                             | OEC / PEC | -             | 3               | 3  | 0 | 0  | 3  |
| <b>PRACTICAL</b>                    |             |                                                |           |               |                 |    |   |    |    |
| 6                                   | 22MEP03     | Thermal Engineering Systems Laboratory         | PCC       | -             | 4               | 0  | 0 | 4  | 2  |
| 7                                   | 22MEP04     | Subtractive Manufacturing Processes Laboratory | PCC       | -             | 4               | 0  | 0 | 4  | 2  |
| <b>Mandatory Non Credit Courses</b> |             |                                                |           |               |                 |    |   |    |    |
| 8                                   | 22MAN07R    | Soft/Analytical Skills – III <sup>##</sup>     | MC        | 22MAN04R      | 3               | 1  | 0 | 2  | 0  |
| 9                                   | 22MAN06     | Environmental Science                          | MC        | -             | 2               | 2  | 0 | 0  | 0  |
| 10                                  | 22GED01     | Personality and Character Development          | MC        | -             | 2               | 0  | 0 | 2  | 0  |
| <b>TOTAL</b>                        |             |                                                |           |               | 35              | 18 | 1 | 16 | 22 |

<sup>##</sup> Ratified by Twelfth Academic Council



| SEMESTER: V                         |             |                                           |           |               |                 |           |          |           |           |
|-------------------------------------|-------------|-------------------------------------------|-----------|---------------|-----------------|-----------|----------|-----------|-----------|
| S. NO.                              | COURSE CODE | COURSE TITLE                              | CATEGORY  | PRE-REQUISITE | CONTACT PERIODS | L         | T        | P         | C         |
| <b>THEORY</b>                       |             |                                           |           |               |                 |           |          |           |           |
| 1                                   | 22MECI4     | Machine Design                            | PCC       | -             | 4               | 3         | 1        | 0         | 4         |
| 2                                   | 22MECI5     | Metrology and Measurements                | PCC       | -             | 3               | 3         | 0        | 0         | 3         |
| 3                                   | 22MECI6     | Heat and Mass Transfer                    | PCC       | -             | 3               | 3         | 0        | 0         | 3         |
| 4                                   | 22MECI7     | Hydraulics and Pneumatics                 | PCC       | -             | 3               | 3         | 0        | 0         | 3         |
| 5                                   | E2          | Elective (PEC)                            | PEC       | -             | 3               | 3         | 0        | 0         | 3         |
| 6                                   | E3          | Elective (OEC/PEC)                        | OEC / PEC | -             | 3               | 3         | 0        | 0         | 3         |
| <b>PRACTICAL</b>                    |             |                                           |           |               |                 |           |          |           |           |
| 7                                   | 22MEP05     | Heat and Mass Transfer Laboratory         | PCC       | -             | 4               | 0         | 0        | 4         | 2         |
| 8                                   | 22MEP06     | Metrology and Measurements Laboratory     | PCC       | -             | 4               | 0         | 0        | 4         | 2         |
| <b>Mandatory Non Credit Courses</b> |             |                                           |           |               |                 |           |          |           |           |
| 9                                   | 22MAN08R    | Soft/Analytical Skills – IV <sup>##</sup> | MC        | 22MAN07R      | 3               | 1         | 0        | 2         | 0         |
| <b>TOTAL</b>                        |             |                                           |           |               | <b>30</b>       | <b>19</b> | <b>1</b> | <b>10</b> | <b>23</b> |

<sup>##</sup> Ratified by Twelfth Academic Council

| SEMESTER: VI     |             |                                    |          |               |                 |           |          |           |           |
|------------------|-------------|------------------------------------|----------|---------------|-----------------|-----------|----------|-----------|-----------|
| S. NO.           | COURSE CODE | COURSE TITLE                       | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L         | T        | P         | C         |
| <b>THEORY</b>    |             |                                    |          |               |                 |           |          |           |           |
| 1                | 22MECI8     | Finite Element Analysis            | PCC      | -             | 3               | 3         | 0        | 0         | 3         |
| 2                | 22MECI9     | Mechatronics and IoT               | PCC      | -             | 3               | 3         | 0        | 0         | 3         |
| 3                | EM          | Elective (Management)*             | HSMC     | -             | 3               | 3         | 0        | 0         | 3         |
| 4                | E4          | Elective (PEC)                     | PEC      | -             | 3               | 3         | 0        | 0         | 3         |
| 5                | E5          | Elective (PEC)                     | PEC      | -             | 3               | 3         | 0        | 0         | 3         |
| 6                | E6          | Elective (OEC)                     | OEC      | -             | 3               | 3         | 0        | 0         | 3         |
| <b>PRACTICAL</b> |             |                                    |          |               |                 |           |          |           |           |
| 7                | 22MEP07     | Computer Aided Analysis Laboratory | PCC      | -             | 4               | 0         | 0        | 4         | 2         |
| 8                | 22MEP08     | Mechatronics and IoT Laboratory    | PCC      | -             | 4               | 0         | 0        | 4         | 2         |
| <b>TOTAL</b>     |             |                                    |          |               | <b>26</b>       | <b>18</b> | <b>0</b> | <b>08</b> | <b>22</b> |

\* Ratified by Thirteenth Academic Council

| SEMESTER: VII    |             |                                  |          |               |                 |           |          |          |           |
|------------------|-------------|----------------------------------|----------|---------------|-----------------|-----------|----------|----------|-----------|
| S. NO.           | COURSE CODE | COURSE TITLE                     | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L         | T        | P        | C         |
| <b>THEORY</b>    |             |                                  |          |               |                 |           |          |          |           |
| 1                | 22MEC20     | CAD/CAM/CIM                      | PCC      | -             | 3               | 3         | 0        | 0        | 3         |
| 2                | 22GEA01     | Universal Human Values           | HSMC     | -             | 2               | 2         | 0        | 0        | 2         |
| 3                | E7          | Elective (PEC)                   | PEC      | -             | 3               | 3         | 0        | 0        | 3         |
| 4                | E8          | Elective (PEC)                   | PEC      | -             | 3               | 3         | 0        | 0        | 3         |
| 5                | E9          | Elective (PEC)                   | PEC      | -             | 3               | 3         | 0        | 0        | 3         |
| 6                | E10         | Elective (OEC)                   | OEC      | -             | 3               | 3         | 0        | 0        | 3         |
| <b>PRACTICAL</b> |             |                                  |          |               |                 |           |          |          |           |
| 7                | 22MEP09     | CAD / CAM Laboratory             | PCC      | -             | 4               | 0         | 0        | 4        | 2         |
| 8                | 22GED02     | Internship / Industrial Training | EEC      | -             | 0               | 0         | 0        | 0        | 2         |
| <b>TOTAL</b>     |             |                                  |          |               | <b>21</b>       | <b>17</b> | <b>0</b> | <b>4</b> | <b>21</b> |

| SEMESTER: VIII   |             |              |          |               |                 |          |          |           |           |
|------------------|-------------|--------------|----------|---------------|-----------------|----------|----------|-----------|-----------|
| S. NO.           | COURSE CODE | COURSE TITLE | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L        | T        | P         | C         |
| <b>PRACTICAL</b> |             |              |          |               |                 |          |          |           |           |
| 1                | 22MED01     | Project Work | EEC      | -             | 20              | 0        | 0        | 20        | 10        |
| <b>TOTAL</b>     |             |              |          |               | <b>20</b>       | <b>0</b> | <b>0</b> | <b>20</b> | <b>10</b> |

**(A) HSC, BSC AND ESC COURSES****(a) Humanities and Social Sciences (HS)**

| S. NO. | COURSE CODE | COURSE TITLE                                      | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L | T | P | C | P.S |
|--------|-------------|---------------------------------------------------|----------|---------------|-----------------|---|---|---|---|-----|
| 1      | 22EYA01     | Professional Communication - I                    | HSMC     | -             | 4               | 2 | 0 | 2 | 3 | I   |
| 2      | 22GYA01     | தமிழர்மரபு / Heritage of Tamils                   | HSMC     | -             | 1               | 1 | 0 | 0 | 1 | I   |
| 3      | 22EYA02     | Professional Communication - II                   | HSMC     | 22EYA01       | 4               | 2 | 0 | 2 | 3 | II  |
| 4      | 22GYA02     | தமிழரும் தொழில் நுட்பமும் / Tamils and Technology | HSMC     | -             | 1               | 1 | 0 | 0 | 1 | II  |
| 5      | 22GEA01     | Universal Human Values                            | HSMC     | -             | 2               | 2 | 0 | 0 | 2 | VII |
| 6      | EM          | Elective (Management)                             | HSMC     | -             | 3               | 3 | 0 | 0 | 3 | VI  |

**(b) Basic Sciences (BSC)**

| S. NO. | COURSE CODE | COURSE TITLE                                            | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L | T | P | C | P.S |
|--------|-------------|---------------------------------------------------------|----------|---------------|-----------------|---|---|---|---|-----|
| 1      | 22MYB01     | Calculus and linear algebra                             | BSC      | -             | 4               | 3 | 1 | 0 | 4 | I   |
| 2      | 22CYB02     | Chemistry for Engineers                                 | BSC      | -             | 3               | 3 | 0 | 0 | 3 | I   |
| 3      | 22CYP01     | Chemistry Laboratory                                    | BSC      | -             | 2               | 0 | 0 | 2 | 1 | I   |
| 4      | 22MYB02     | Partial Differential Equations and Transform Techniques | BSC      | -             | 4               | 3 | 1 | 0 | 4 | II  |
| 5      | 22PYB04     | Physics for Mechanical Engineering                      | BSC      | -             | 3               | 3 | 0 | 0 | 3 | II  |
| 6      | 22PYP01     | Physics Laboratory                                      | BSC      | -             | 2               | 0 | 0 | 2 | 1 | II  |
| 7      | 22MYB03     | Statistics And Numerical Methods                        | BSC      | -             | 4               | 3 | 1 | 0 | 4 | III |

**(c) Engineering Sciences (ESC)**

| S. NO. | COURSE CODE | COURSE TITLE                                      | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L | T | P | C | P.S |
|--------|-------------|---------------------------------------------------|----------|---------------|-----------------|---|---|---|---|-----|
| 1      | 22EEC02     | Basic Electrical Engineering                      | ESC      | -             | 3               | 3 | 0 | 0 | 3 | I   |
| 2      | 22MEC02     | Engineering Graphics and Drafting (Theory + Lab)  | ESC      | -             | 5               | 3 | 0 | 2 | 4 | I   |
| 3      | 22GEP01     | Engineering Practices Laboratory                  | ESC      | -             | 4               | 0 | 0 | 4 | 2 | I   |
| 4      | 22CSC01     | Problem Solving and C Programming                 | ESC      | -             | 3               | 3 | 0 | 0 | 3 | II  |
| 5      | 22ECC03     | Basic Electronics and Instrumentation Engineering | ESC      | -             | 3               | 3 | 0 | 0 | 3 | II  |
| 6      | 22MEC03     | Engineering Mechanics                             | ESC      | -             | 3               | 2 | 1 | 0 | 3 | II  |
| 7      | 22CSP01     | Problem Solving and C Programming Laboratory      | ESC      | -             | 4               | 0 | 0 | 4 | 2 | II  |

|   |         |                                              |     |   |   |   |   |   |   |     |
|---|---------|----------------------------------------------|-----|---|---|---|---|---|---|-----|
| 8 | 22MEC05 | Fluid Mechanics and Machinery (Theory + Lab) | ESC | - | 5 | 3 | 0 | 2 | 4 | III |
| 9 | 22MEP02 | Computer Aided Machine Drawing               | BSC | - | 4 | 0 | 0 | 4 | 2 | III |

#### Mandatory Courses (MC)

| S. NO. | COURSE CODE | COURSE TITLE                          | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L | T | P | C | P.S |
|--------|-------------|---------------------------------------|----------|---------------|-----------------|---|---|---|---|-----|
| 1      | 22MAN01     | Induction Programme                   | MC       | -             | 0               | 0 | 0 | 0 | 0 | I   |
| 2      | 22MAN03     | Yoga - I                              | MC       | -             | 1               | 0 | 0 | 1 | 0 | I   |
| 3      | 22MAN02R    | Soft /Analytical Skills - I           | MC       | -             | 3               | 1 | 0 | 2 | 0 | II  |
| 4      | 22MAN05     | Yoga - II                             | MC       | -             | 1               | 0 | 0 | 1 | 0 | II  |
| 5      | 22MAN04R    | Soft /Analytical Skills - II          | MC       | 22MAN02R      | 3               | 1 | 0 | 2 | 0 | III |
| 6      | 22MAN09     | Indian Constitution                   | MC       | -             | 1               | 1 | 0 | 0 | 0 | III |
| 7      | 22MAN07R    | Soft / Analytical Skills - III        | MC       | 22MAN04R      | 3               | 1 | 0 | 2 | 0 | IV  |
| 8      | 22MAN06     | Environmental Science                 | MC       | -             | 2               | 2 | 0 | 0 | 0 | IV  |
| 9      | 22GED01     | Personality and Character Development | MC       | -             | 1               | 0 | 0 | 1 | 0 | IV  |
| 10     | 22MAN08R    | Soft/Analytical Skills - IV           | MC       | 22MAN07R      | 3               | 1 | 0 | 2 | 0 | V   |

#### (B) PROFESSIONAL CORE COURSES (PCC)

| S. NO. | COURSE CODE | COURSE TITLE                         | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L | T | P | C | P.S |
|--------|-------------|--------------------------------------|----------|---------------|-----------------|---|---|---|---|-----|
| 1      | 22MEC04     | Engineering Thermodynamics           | PCC      | -             | 3               | 2 | 1 | 0 | 3 | III |
| 2      | 22MEC06     | Manufacturing Processes              | PCC      | -             | 3               | 3 | 0 | 0 | 3 | III |
| 3      | 22MEC07     | Engineering Materials and Metallurgy | PCC      | -             | 3               | 3 | 0 | 0 | 3 | III |
| 4      | 22MEC09     | Thermal Engineering Systems          | PCC      | 22MEC04       | 4               | 3 | 1 | 0 | 4 | IV  |
| 5      | 22MEC10     | Subtractive Manufacturing Processes  | PCC      | 22MEC06       | 3               | 3 | 0 | 0 | 3 | IV  |
| 6      | 22MEC11     | Strength of Materials (Theory + Lab) | PCC      | -             | 5               | 3 | 0 | 2 | 4 | IV  |

|    |         |                                                |     |   |   |   |   |   |   |     |
|----|---------|------------------------------------------------|-----|---|---|---|---|---|---|-----|
| 7  | 22MECI2 | Theory of Machines (Theory + Lab)              | PCC | - | 5 | 3 | 0 | 2 | 4 | IV  |
| 8  | 22MEP03 | Thermal Engineering Systems Laboratory         | PCC | - | 4 | 0 | 0 | 4 | 2 | IV  |
| 9  | 22MEP04 | Subtractive Manufacturing Processes Laboratory | PCC | - | 4 | 0 | 0 | 4 | 2 | IV  |
| 10 | 22MECI4 | Machine Design                                 | PCC | - | 4 | 3 | 1 | 0 | 4 | V   |
| 11 | 22MECI5 | Metrology and Measurements                     | PCC | - | 3 | 3 | 0 | 0 | 3 | V   |
| 12 | 22MECI6 | Heat and Mass Transfer                         | PCC | - | 3 | 3 | 0 | 0 | 3 | V   |
| 13 | 22MECI7 | Hydraulics and Pneumatics                      | PCC | - | 3 | 3 | 0 | 0 | 3 | V   |
| 14 | 22MEP05 | Heat and Mass Transfer Laboratory              | PCC | - | 4 | 0 | 0 | 4 | 2 | V   |
| 15 | 22MEP06 | Metrology and Measurements Laboratory          | PCC | - | 4 | 0 | 0 | 4 | 2 | V   |
| 16 | 22MECI8 | Finite Element Analysis                        | PCC | - | 3 | 3 | 0 | 0 | 3 | VI  |
| 17 | 22MECI9 | Mechatronics and IoT                           | PCC | - | 3 | 3 | 0 | 0 | 3 | VI  |
| 18 | 22MEP07 | Computer Aided Analysis Laboratory             | PCC | - | 4 | 0 | 0 | 4 | 2 | VI  |
| 19 | 22MEP08 | Mechatronics and IoT Laboratory                | PCC | - | 4 | 0 | 0 | 4 | 2 | VI  |
| 20 | 22MEC20 | CAD/CAM/CIM                                    | PCC | - | 3 | 3 | 0 | 0 | 3 | VII |
| 21 | 22MEP09 | CAD/CAM Laboratory                             | PCC | - | 4 | 0 | 0 | 4 | 2 | VII |

### (C) Employability Enhancement Courses (EEC)

| S. NO. | COURSE CODE | COURSE TITLE                       | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L | T | P  | C  | P.S  |
|--------|-------------|------------------------------------|----------|---------------|-----------------|---|---|----|----|------|
| 1.     | 22GED02     | Internship / Industrial Training * | EEC      | -             | 0               | 0 | 0 | 0  | 2  | VII  |
| 2.     | 22MED01     | Project Work                       | EEC      | -             | 20              | 0 | 0 | 20 | 10 | VIII |

### VERTICAL I DESIGN ENGINEERING

| S. NO. | COURSE CODE | COURSE TITLE        | CATEGORY | PRE - REQUISITE | CONTACT PERIODS | L | T | P | C | P.S     |
|--------|-------------|---------------------|----------|-----------------|-----------------|---|---|---|---|---------|
| 1.     | 22MEX01     | Composite Materials | PEC      | -               | 3               | 3 | 0 | 0 | 3 | V - VII |
| 2.     | 22MEX02     | Tool Design         | PEC      | -               | 3               | 3 | 0 | 0 | 3 | V - VII |

|    |         |                                     |     |         |   |   |   |   |   |         |
|----|---------|-------------------------------------|-----|---------|---|---|---|---|---|---------|
| 3. | 22MEX03 | Non-traditional Machining Processes | PEC | -       | 3 | 3 | 0 | 0 | 3 | V - VII |
| 4. | 22MEX04 | Design Concepts in Engineering      | PEC | -       | 3 | 3 | 0 | 0 | 3 | V - VII |
| 5. | 22MEX05 | Design of Transmission System       | PEC | 22MECI4 | 3 | 2 | 1 | 0 | 3 | V - VII |
| 6. | 22MEX06 | Automobile Engineering              | PEC | 22MEC09 | 3 | 3 | 0 | 0 | 3 | V - VII |
| 7. | 22MEX07 | Industrial Layout Design and Safety | PEC | -       | 3 | 3 | 0 | 0 | 3 | V - VII |
| 8. | 22MEX08 | Modern Robotics                     | PEC | -       | 3 | 3 | 0 | 0 | 3 | V - VII |

## VERTICAL 2 MODERN MOBILITY SYSTEMS

| S. NO. | COURSE CODE | COURSE TITLE                                                           | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L | T | P | C | P.S     |
|--------|-------------|------------------------------------------------------------------------|----------|---------------|-----------------|---|---|---|---|---------|
| 1.     | 22MEX11     | Automotive Materials, Components, Design and Testing                   | PEC      | -             | 3               | 2 | 0 | 2 | 3 | V - VII |
| 2.     | 22MEX12     | Conventional and Futuristic Vehicle Technology                         | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 3.     | 22MEX13     | Renewable Powered Off Highway Vehicles and Emission Control Technology | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 4.     | 22MEX14     | Vehicle Health Monitoring, Maintenance and Safety                      | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 5.     | 22MEX15     | CAE and CFD Approach in Future Mobility                                | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 6.     | 22MEX16     | Hybrid and Electric Vehicle Technology                                 | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 7.     | 22MEX17     | Thermal Management of Batteries and Fuel Cells                         | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 8.     | 22MEX18     | Smart Mobility and Intelligent Vehicles                                | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |

| VERTICAL 3 THERMAL ENGINEERING       |             |                                                             |          |               |                 |   |   |   |   |         |
|--------------------------------------|-------------|-------------------------------------------------------------|----------|---------------|-----------------|---|---|---|---|---------|
| S. NO.                               | COURSE CODE | COURSE TITLE                                                | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L | T | P | C | P.S     |
| 1.                                   | 22MEX21     | Turbo Machines                                              | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 2.                                   | 22MEX22     | Advanced Internal Combustion Engineering                    | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 3.                                   | 22MEX23     | Gas Dynamics and Jet Propulsion                             | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 4.                                   | 22MEX24     | Refrigeration and Air Conditioning                          | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 5.                                   | 22MEX25     | Thermal Power Engineering                                   | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 6.                                   | 22MEX26     | Renewable Energy Technologies                               | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 7.                                   | 22MEX27     | Advanced Vehicle Engineering                                | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 8.                                   | 22MEX28     | Power Plant Engineering                                     | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 9.                                   | 22MEX29     | Green Engineering and AI-Driven Energy Systems <sup>#</sup> | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| VERTICAL 4 COMPUTATIONAL ENGINEERING |             |                                                             |          |               |                 |   |   |   |   |         |
| S. NO.                               | COURSE CODE | COURSE TITLE                                                | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L | T | P | C | P.S     |
| 1.                                   | 22MEX31     | Computational Solid Mechanics                               | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 2.                                   | 22MEX32     | Computational Fluid Dynamics and Heat transfer              | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 3.                                   | 22MEX33     | Theory on Computation and Visualization                     | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 4.                                   | 22MEX34     | Computational Bio-Mechanics                                 | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 5.                                   | 22MEX35     | Design of Pressure Vessels                                  | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 6.                                   | 22MEX36     | CAD and CAE                                                 | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 7.                                   | 22MEX37     | Failure Analysis and NDT Techniques                         | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |

# Ratified by Fourteenth BoS meeting



|    |         |                                          |     |   |   |   |   |   |   |         |
|----|---------|------------------------------------------|-----|---|---|---|---|---|---|---------|
| 8. | 22MEX38 | Machine Learning for Intelligent Systems | PEC | - | 3 | 3 | 0 | 0 | 3 | V - VII |
|----|---------|------------------------------------------|-----|---|---|---|---|---|---|---------|

#### VERTICAL 5 DIGITAL AND GREEN MANUFACTURING

| S. NO. | COURSE CODE | COURSE TITLE                                     | CATEGORY | PRE-REQUISITE | CONTACT PERIODS | L | T | P | C | P.S     |
|--------|-------------|--------------------------------------------------|----------|---------------|-----------------|---|---|---|---|---------|
| 1.     | 22MEX41     | Digital Manufacturing and IoT                    | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 2.     | 22MEX42     | Additive Manufacturing                           | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 3.     | 22MEX43     | Green Manufacturing Design and Practices         | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 4.     | 22MEX44     | Casting and Welding Processes                    | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 5.     | 22MEX45     | Environment Sustainability and Impact Assessment | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 6.     | 22MEX46     | Surface Engineering                              | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 7.     | 22MEX47     | Green Supply Chain Management                    | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 8.     | 22MEX48     | Product Life Cycle Management                    | PEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |

#### (E) MINOR DEGREE

#### MINOR I ELECTRIC VEHICLE TECHNOLOGIES

| S. NO. | COURSE CODE | COURSE TITLE                                     | CATEGORY | PRE REQUISITE | CONTACT PERIODS | L | T | P | C | P.S     |
|--------|-------------|--------------------------------------------------|----------|---------------|-----------------|---|---|---|---|---------|
| 1.     | 22MEM01     | Basics of Electric Vehicles                      | OEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 2.     | 22MEM02     | Electric Vehicle Architecture and Control System | OEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 3.     | 22MEM03     | Materials for Electric Vehicles                  | OEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 4.     | 22MEM04     | Powertrain Design for Electric Vehicles          | OEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 5.     | 22MEM05     | Battery Management                               | OEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 6.     | 22MEM06     | AI and IoT for Electric Vehicles                 | OEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 7.     | 22MEM07     | Autonomous Vehicles                              | OEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |
| 8.     | 22MEM08     | Fuel Cell Technology and Safety Regulations      | OEC      | -             | 3               | 3 | 0 | 0 | 3 | V - VII |

**(F) MANAGEMENT ELECTIVES**

|    |         |                              |      |   |   |   |   |   |   |    |
|----|---------|------------------------------|------|---|---|---|---|---|---|----|
| 1. | 22GEA02 | Principles of Management     | HSMC | - | 3 | 3 | 0 | 0 | 3 | VI |
| 2. | 22GEA03 | Total Quality Management     | HSMC | - | 3 | 3 | 0 | 0 | 3 | VI |
| 3. | 22GEA04 | Professional Ethics          | HSMC | - | 3 | 3 | 0 | 0 | 3 | VI |
| 4. | 22GEZ01 | Entrepreneurship Development | HSMC |   | 3 | 3 | 0 | 0 | 3 | VI |

**(G) OPEN ELECTIVES**

|    |         |                                      |     |   |   |   |   |   |   |       |
|----|---------|--------------------------------------|-----|---|---|---|---|---|---|-------|
| 1. | 22MEZ01 | Value Engineering                    | OEC | - | 3 | 3 | 0 | 0 | 3 | V-VII |
| 2. | 22MEZ02 | Ergonomics in Design                 | OEC | - | 3 | 3 | 0 | 0 | 3 | V-VII |
| 3. | 22MEZ03 | Industrial safety                    | OEC | - | 3 | 3 | 0 | 0 | 3 | V-VII |
| 4. | 22MEZ04 | Process Planning and Cost Estimation | OEC | - | 3 | 3 | 0 | 0 | 3 | V-VII |

**Summary of Credit Distribution**

| <b>B.E. – MECHANICAL ENGINEERING</b> |                     |                                |           |            |           |           |           |            |             |                      |                     |
|--------------------------------------|---------------------|--------------------------------|-----------|------------|-----------|-----------|-----------|------------|-------------|----------------------|---------------------|
| <b>S. NO.</b>                        | <b>SUBJECT AREA</b> | <b>CREDITS AS PER SEMESTER</b> |           |            |           |           |           |            |             | <b>TOTAL CREDITS</b> | <b>PERCENTAGE %</b> |
|                                      |                     | <b>I</b>                       | <b>II</b> | <b>III</b> | <b>IV</b> | <b>V</b>  | <b>VI</b> | <b>VII</b> | <b>VIII</b> |                      |                     |
| 1                                    | HSMC                | 4                              | 4         |            |           |           | 3         | 2          |             | 13                   | 8.07                |
| 2                                    | BSC                 | 8                              | 8         | 4          |           |           |           |            |             | 20                   | 12.42               |
| 3                                    | ESC                 | 9                              | 11        | 6          |           |           |           |            |             | 26                   | 16.15               |
| 4                                    | PCC                 |                                |           | 9          | 19        | 17        | 10        | 5          |             | 60                   | 37.27               |
| 5                                    | PEC                 |                                |           |            |           | 3         | 6         | 9          |             | 18                   | 11.18               |
| 6                                    | OEC                 |                                |           |            |           |           | 3         | 3          |             | 6                    | 3.73                |
| 7                                    | PEC/ OEC            |                                |           |            | 3         | 3         |           |            |             | 6                    | 3.73                |
| 8                                    | EEC                 |                                |           |            |           |           |           | 2          | 10          | 12                   | 7.45                |
| <b>Total Credits</b>                 |                     | <b>21</b>                      | <b>23</b> | <b>19</b>  | <b>22</b> | <b>23</b> | <b>22</b> | <b>21</b>  | <b>10</b>   | <b>161</b>           | <b>100</b>          |

**22MAN01- INDUCTION PROGRAMME**  
(Common To All Branches)

|  | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|--|----------|----------|----------|----------|
|  | -        | -        | -        | -        |

**PRE REQUISITE : NIL**

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

“Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.”

“One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. “

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

**(i) Physical Activity**

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

**(ii) Creative Arts**

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

**(iii) Universal Human Values**

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and don'ts, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing.

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

#### **(iv) Literary Activity**

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

#### **(v) Proficiency Modules**

This would address some lacunas that students might have, for example, English, computer familiarity etc.

#### **(vi) Lectures by Eminent People**

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

#### **(vii) Visits to Local Area**

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

#### **(viii) Familiarization to Dept./Branch & Innovations**

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

#### **(ix) Department Specific Activities**

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering/Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

**Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.**

#### **REFERENCES:**

I. Guide to Induction program from AICTE



| 22EYA01 - PROFESSIONAL COMMUNICATION - I<br>(Common to All Branches) |                                                                                                                                                                                        |                        |                                                     |          |
|----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                                      |                                                                                                                                                                                        | <b>L</b>               | <b>T</b>                                            | <b>P</b> |
|                                                                      |                                                                                                                                                                                        | <b>2</b>               | <b>0</b>                                            | <b>2</b> |
| <b>PREREQUISITE : NIL</b>                                            |                                                                                                                                                                                        |                        |                                                     |          |
| <b>Course Objective:</b>                                             | <ul style="list-style-type: none"> <li>To build essential English skills to address the challenges of communication</li> <li>To enhance communication employing LSRW skills</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to                |                                                                                                                                                                                        | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                                  | Communicate effectively in various work environments.                                                                                                                                  | R                      | 20%                                                 |          |
| CO2                                                                  | Involve in diverse discourse forms utilizing LSRW Skills.                                                                                                                              | U                      | 20%                                                 |          |
| CO3                                                                  | Participate actively in communication activities that enhance the creative skill.                                                                                                      | U                      | 20%                                                 |          |
| CO4                                                                  | Associate with the target audience and contexts using varied types of communication.                                                                                                   | Ap                     | 20%                                                 |          |
| CO5                                                                  | Convey the ideas distinctly both in verbal and non-verbal communication in work culture.                                                                                               | U                      | 20%                                                 |          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <b>UNIT I –INTRODUCTORY SKILLS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | (6+6) |
| <b>Grammar</b> – Parts of Speech – Verb (Auxiliaries – Primary & Modal, Main Verb) - <b>Listening</b> – Listening to Short Conversations or Monologues - Listening to Experiences – Listening to Descriptions- <b>Speaking</b> – Introducing Oneself – Exchanging Personal information - Talking about food and culture - <b>Reading</b> – Reading for Interrogation – Reading Newspaper, Advertisements and Interpreting - <b>Writing</b> - Seeking Permission for Industrial Visit & In-plant Training |       |
| <b>UNIT II – LANGUAGE ACUMEN</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | (6+6) |
| <b>Grammar</b> – Word Formation – Tenses (Present Tense) – Synonyms & Antonyms - <b>Listening</b> – Listening to Announcements – Listening to Interviews - Listening and Note-taking - <b>Speaking</b> – Talking about Holidays & Vacations – Narrating Unforgettable Anecdotes - <b>Reading</b> – Skimming – Scanning (Short Texts and Longer Passages) – Critical Reading - <b>Writing</b> – Instruction – Process Description                                                                         |       |
| <b>UNIT III – COMMUNICATION ROOTERS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | (6+6) |
| <b>Grammar</b> – Cause and Effect – Tenses (Past Tense) – Discourse Markers - <b>Listening</b> – Listening to Telephonic Conversations – Listening to Podcasts - <b>Speaking</b> – Talking about neoteric Technologies – Eliciting information to fill a form - <b>Reading</b> –Book Reading(Motivational) - Practicing Speed Reading (reading newspaper reports & biographies) - <b>Writing</b> – Checklist – Circular, Agenda & Minutes of the Meeting                                                 |       |

|                                                                                                                                                                                                                                                                                                                      |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <b>UNIT IV - DISCOURSE FORTE</b>                                                                                                                                                                                                                                                                                     | (6+6) |
| <b>Grammar</b> – Tenses (Future Tense) –Yes/No & WH type questions – Negatives - <b>Listening</b> – Listening to TED/ Ink talks - <b>Speaking</b> – Participating in Short Conversations - <b>Reading</b> – Reading Comprehension (Multiple Choice / Short / Open Ended Questions) - <b>Writing</b> - E-Mail Writing |       |
| <b>UNIT V - LINGUISTIC COMPETENCIES</b>                                                                                                                                                                                                                                                                              | (6+6) |
| <b>Grammar</b> – Articles – Homophones & Homonyms – Single line Definition – Phrasal Verb - <b>Listening</b> – Intensive listening to fill in the gapped text - <b>Speaking</b> –Expressing opinions through Situations & Role play - <b>Reading</b> – Cloze Texts - <b>Writing</b> – Paragraph Writing              |       |
| <p style="text-align: center;"><b>LIST OF SKILLS ASSESSED IN THE LABORATORY</b></p> <ol style="list-style-type: none"> <li>1. Grammar</li> <li>2. Listening Skills</li> <li>3. Speaking Skills</li> <li>4. Reading Skills</li> <li>5. Writing Skills</li> </ol>                                                      |       |
| <b>TOTAL (L:30 , P:30) = 60 PERIODS</b>                                                                                                                                                                                                                                                                              |       |

|                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                       |
| <ol style="list-style-type: none"> <li>1. Shoba K N., Deepa Mary Francis. <i>English for Engineers and Technologists</i>. Volume I, 3rd Edition, Orient Black Swan Pvt. Ltd, Telangana, 2022.</li> </ol>                                                                                                                                                                                                                 |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                       |
| <ol style="list-style-type: none"> <li>1. Koneru, Aruna. <i>English Language Skills</i>. Tata McGraw Hill Education (India) Private Limited, Chennai, 2006.</li> <li>2. Hewings, M. <i>Advanced English Grammar</i>. Cambridge University Press, Chennai, 2000.</li> <li>3. Jack C Richards, Jonathan Hull and Susan Proctor. <i>Interchange</i>. Cambridge University Press, New Delhi, 2015 (Reprint 2021).</li> </ol> |
| <b>WEB REFERENCE:</b>                                                                                                                                                                                                                                                                                                                                                                                                    |
| <ol style="list-style-type: none"> <li>1. <a href="https://youtu.be/f0uqUzEf3A8?si=vyzu5KGlfbu35_IQ">https://youtu.be/f0uqUzEf3A8?si=vyzu5KGlfbu35_IQ</a></li> </ol>                                                                                                                                                                                                                                                     |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | I   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | I    | 2 |
| 1                              |     |   |   |   |   |   |   | 2 | 3 |    |    |      |   |
| 2                              |     |   |   |   |   |   |   | 2 | 3 |    |    |      |   |
| 3                              |     |   |   |   |   |   |   | 2 | 3 |    |    |      |   |
| 4                              |     |   |   |   |   |   |   | 2 | 3 |    |    |      |   |
| 5                              |     |   |   |   |   |   |   | 2 | 3 |    |    |      |   |
| CO (W.A)                       |     |   |   |   |   |   |   | 2 | 3 |    |    |      |   |

M. 48

| 22MYB01 - CALCULUS AND LINEAR ALGEBRA<br>(Common to All Branches)                                                                                                                                                             |                                                                                                                                                                                                                                                                       |                 |                                              |       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|-------|
|                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                       | L               | T                                            | P     |
|                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                       | 3               | 1                                            | 0     |
| PREREQUISITE : NIL                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                       |                 |                                              |       |
| Course Objective:                                                                                                                                                                                                             | <ul style="list-style-type: none"> <li>To understand the mathematical concepts of matrices and analytical geometry in real time problems.</li> <li>To formulate differential and integral equations to model physical, biological, and engineering systems</li> </ul> |                 |                                              |       |
| Course Outcomes<br>The Student will be able to                                                                                                                                                                                |                                                                                                                                                                                                                                                                       | Cognitive Level | Weightage of COs in End Semester Examination |       |
| CO1                                                                                                                                                                                                                           | Apply the concepts of matrix theory for find solutions to complex problems efficiently.                                                                                                                                                                               | Ap              | 20%                                          |       |
| CO2                                                                                                                                                                                                                           | Analyze the geometric configurations and relationships by using Analytical geometry.                                                                                                                                                                                  | An              | 20%                                          |       |
| CO3                                                                                                                                                                                                                           | Interpret the partial derivatives which involve heat conduction problems modeled by the heat equation.                                                                                                                                                                | Ap              | 20%                                          |       |
| CO4                                                                                                                                                                                                                           | Apply the differential and integral techniques to solve the differential equations and multiple integrals in heat conduction, fluid mechanics and potential theory.                                                                                                   | Ap              | 40%                                          |       |
| CO5                                                                                                                                                                                                                           | Demonstrate the importance of matrix theory, analytical geometry and integral methods using programming tools.                                                                                                                                                        | Ap              | Internal Assessment                          |       |
| UNITI-MATRICES                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                       |                 |                                              | (9+3) |
| Characteristic Equation-Eigen values and Eigen vectors of a matrix- Cayley Hamilton Theorem(excluding proof)and its applications-Quadratic Form-Reduction of a Quadratic form to canonical form by orthogonal transformation. |                                                                                                                                                                                                                                                                       |                 |                                              |       |
| UNITII-ANALYTICAL GEOMETRY OF THREE DIMENSIONS                                                                                                                                                                                |                                                                                                                                                                                                                                                                       |                 |                                              | (9+3) |
| Equation of plane–Angle between two planes–Equation of straight lines–Coplanar lines–Equation of sphere –Orthogonal spheres.                                                                                                  |                                                                                                                                                                                                                                                                       |                 |                                              |       |
| UNITIII-GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS                                                                                                                                                                     |                                                                                                                                                                                                                                                                       |                 |                                              | (9+3) |
| Curvature–Curvature in Cartesian co-ordinates-Centre and Radius of curvature-Circle of curvature-Evolutes and Involutives.                                                                                                    |                                                                                                                                                                                                                                                                       |                 |                                              |       |
| UNITIV-FUNCTIONS OF SEVERAL VARIABLES                                                                                                                                                                                         |                                                                                                                                                                                                                                                                       |                 |                                              | (9+3) |
| Partial derivatives-Euler's theorem on homogeneous function-Jacobian-Maxima and Minima of functions of Two variables-Constrained Maxima and Minima by Lagrange's multiplier method.                                           |                                                                                                                                                                                                                                                                       |                 |                                              |       |
| UNITV-MULTIPLE INTEGRALS                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                       |                 |                                              | (9+3) |
| Double integration in Cartesian Co-ordinates-Change of order of integration-Area as double integral-Triple Integration in Cartesian Co-ordinates-Volume as triple integrals.                                                  |                                                                                                                                                                                                                                                                       |                 |                                              |       |
| TOTAL(L:45+T:15) :60PERIODS                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                       |                 |                                              |       |

**LIST OF PROGRAMS USING MATLAB (Assignment/Online Test):**

1. Introduction to MATLAB
2. Matrix operations—Addition, Multiplication, Transpose and Inverse
3. Characteristic equation of a Matrix
4. Eigen values and Eigen vectors of Higher order Matrices.
5. Curve Tracing
6. Determining Maxima and Minima of a function of one variable.
7. Determining Maxima and Minima of a function of two variables.
8. Evaluating double integrals
9. Evaluating triple integrals
10. Finding area between two curves.

**TEXT BOOKS:**

1. Grewal,B.S., “Higher Engineering Mathematics”, Khanna publications,42<sup>nd</sup> Edition,2012.
2. ErwinKreyszig, “Advanced Engineering mathematics”,JohnWiley&sons,9<sup>th</sup> Edition,2013.
3. Veerarajan,T., “Engineering Mathematics of semesterI&II”,TataMcGrawHill,3<sup>rd</sup> Edition,2016.

**REFERENCES:**

1. Bali,N.P.,ManishGoyal,“A Textbook of Engineering Mathematics-Sem-II”, Laxmi Publications,6<sup>th</sup> Edition,2014.
2. Kandasamy,P.,Thilagavathy,K.,Gunavathy,K., “Engineering Mathematics for first year”,Scand & Co Ltd,9<sup>th</sup> Revised Edition,2013.
3. GlynJames,“Advanced Engineering Mathematics”,Wiley India,7<sup>th</sup> Edition,2007.

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 2                              |     | 2 |   |   |   |   |   |   |   |    |    |      |   |
| 3                              |     | 2 |   |   |   |   |   |   |   |    |    |      |   |
| 4                              | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 5                              | 3   |   |   |   | 2 |   |   | 3 |   |    | 2  |      |   |
| CO (W.A)                       | 3   | 2 |   |   | 2 |   |   | 3 |   |    | 2  |      |   |





| 22CYB02 - CHEMISTRY FOR ENGINEERS<br>(Common to Civil and Mechanical Engineering Branches) |                                                                                                       |                                                                                                                                                                                                                                                                                                                          |                 |                                              |   |   |
|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                                                            |                                                                                                       |                                                                                                                                                                                                                                                                                                                          | L               | T                                            | P | C |
|                                                                                            |                                                                                                       |                                                                                                                                                                                                                                                                                                                          | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                                                                         |                                                                                                       |                                                                                                                                                                                                                                                                                                                          |                 |                                              |   |   |
| Course Objective:                                                                          |                                                                                                       | <ul style="list-style-type: none"><li>• To make the students conversant with water treatment, boiler feed water techniques, energy storage devices and corrosive nature of metals.</li><li>• To impart knowledge on the basic principles, preparatory methods of nanomaterials and combustion nature of fuels.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to                                             |                                                                                                       |                                                                                                                                                                                                                                                                                                                          | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                                                                        | Predict the nature, oxidation and reduction potential of an electrode.                                |                                                                                                                                                                                                                                                                                                                          | An              | 20%                                          |   |   |
| CO2                                                                                        | Investigate on renewable energy sources like nuclear, solar, wind energy and also on storage devices. |                                                                                                                                                                                                                                                                                                                          | E               | 20%                                          |   |   |
| CO3                                                                                        | Identify the types of hardness in water and its removal by various water treatment techniques.        |                                                                                                                                                                                                                                                                                                                          | Ap              | 20%                                          |   |   |
| CO4                                                                                        | Explore the type of corrosion and its control measures.                                               |                                                                                                                                                                                                                                                                                                                          | An              | 20%                                          |   |   |
| CO5                                                                                        | Recommend suitable fuels for engineering processes and applications.                                  |                                                                                                                                                                                                                                                                                                                          | E               | 20%                                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT I – ELECTROCHEMISTRY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                           | (9) |
| Electrode potential - Nernst equation - derivation and problems - reference electrodes - standard hydrogen electrode - calomel electrode - electrochemical series - significance - Types of cell - electrolytic and electrochemical cells - reversible and irreversible cells - potentiometric titrations (redox) - conductometric titrations (acid-base).                                                                                                                                 |     |
| <b>UNIT II - ENERGY SOURCES AND STORAGE DEVICES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                        | (9) |
| Nuclear energy - nuclear fission - nuclear fusion - light water nuclear power plants - breeder reactor – solar energy conversion - solar cells - solar water heater - Recent developments in solar cell materials - wind energy - batteries - types of batteries - lead acid storage battery - lithium-ion battery, Electric vehicles - working principles.                                                                                                                                |     |
| <b>UNIT III - WATER TECHNOLOGY AND NANO MATERIALS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                      | (9) |
| Municipal water treatment - disinfection methods (UV, ozonation, chlorination) - desalination of brackish water - reverse osmosis - boiler troubles (scale, sludge, priming, foaming and caustic embrittlement) - treatment of boiler feed water - internal treatment (carbonate, phosphate and calgon conditioning) - external treatment - demineralization process. Nanomaterials - synthesis (laser ablation, and chemical vapour deposition method) and applications of nanomaterials. |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT IV - CORROSION AND ITS CONTROL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>(9)</b> |
| Corrosion - types - chemical corrosion - pilling bedworth rule - electrochemical corrosion - mechanism- galvanic corrosion - differential aeration corrosion - factors influencing corrosion - corrosion control - sacrificial anode and impressed cathodic current methods - corrosion inhibitors - protective coatings - paints - constituents and their functions                                                                                                                                             |            |
| <b>UNIT V - FUELS AND COMBUSTION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>(9)</b> |
| Fuels: Introduction: Classification of fuels: Coal and coke: Analysis of coal (Proximate) - Carbonization - Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process) - Knocking - octane number - diesel oil - cetane number: Power alcohol and biodiesel.<br>Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Flue gas analysis - ORSAT method. CO <sub>2</sub> emission and carbon foot print. |            |
| <b>TOTAL (L:45) : 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |            |

|                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                      |
| <ol style="list-style-type: none"> <li>1. Dr.Ravikrishnan, A,"Engineering Chemistry I &amp; Engineering Chemistry II", Sri Krishna Hitech Publishing chem., Co. Pvt Ltd., 13th Edition, Chennai, 2020.</li> <li>2. S.S. Dara," A Text book of Engineering Chemistry", S.Chand &amp; Co.Ltd. New Delhi, 2019.</li> </ol> |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                      |
| <ol style="list-style-type: none"> <li>1. P.C.Jain and Monica Jain, "Engineering Chemistry", Vol I &amp;II, DhanpatRai Pub, Co,New Delhi 15th ed.,2018.</li> <li>2. B.Sivasankar, "Engineering Chemistry" , Tata McGraw- Hill Pub.Co.Ltd.,New Delhi,2018</li> </ol>                                                     |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   | 2 |   |    |    |      |   |
| 2                              |     | 2 |   |   |   |   |   |   |   |    |    |      |   |
| 3                              |     |   |   |   |   |   |   |   |   |    |    |      |   |
| 4                              |     |   | 2 |   |   | 2 |   |   |   |    |    |      |   |
| 5                              |     | 2 |   |   |   | 2 |   |   |   |    | 2  |      |   |
| CO (W.A)                       | 3   | 2 | 2 |   |   | 2 |   | 2 |   |    | 2  |      |   |

M. 42

| 22EEEC02 - BASIC ELECTRICAL ENGINEERING        |                                                                                                                                                  |                                                                                       |                                              |   |                                                                                                   |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|----------------------------------------------|---|---------------------------------------------------------------------------------------------------|
|                                                |                                                                                                                                                  | L                                                                                     | T                                            | P | C                                                                                                 |
|                                                |                                                                                                                                                  | 3                                                                                     | 0                                            | 0 | 3                                                                                                 |
| PREREQUISITE : NIL                             |                                                                                                                                                  |                                                                                       |                                              |   |                                                                                                   |
| Course Objective:                              |                                                                                                                                                  | • To impart knowledge on the concepts of electrical circuit laws, AC and DC machines. |                                              |   | • To Gain information on the basic principles of transformers, electric drives with applications. |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                  | Cognitive Level                                                                       | Weightage of COs in End Semester Examination |   |                                                                                                   |
| CO1                                            | Analyze the basic electric laws for AC and DC circuits and investigates the behavior of basic electrical machines.                               | An                                                                                    | 20%                                          |   |                                                                                                   |
| CO2                                            | Apply the characteristics of AC machines and DC machines and predict the selection of electric drives.                                           | Ap                                                                                    | 40%                                          |   |                                                                                                   |
| CO3                                            | Illustrate the operation transformers and its application.                                                                                       | Ap                                                                                    | 20%                                          |   |                                                                                                   |
| CO4                                            | Apply the various categories of AC and DC electric drives for various applications.                                                              | Ap                                                                                    | 20%                                          |   |                                                                                                   |
| CO5                                            | Achieve as an independent learner in a team to build an authentic application of electrical engineering and make an effective oral presentation. | C                                                                                     | Internal Assessment (Seminar)                |   |                                                                                                   |

|                                                                                                                                                                                                                                                                               |  |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----|
| UNIT I - ELECTRIC CIRCUITS                                                                                                                                                                                                                                                    |  | (9) |
| Introduction to DC circuits-Ohm’s Law – Kirchhoff’s Laws – Resistive circuits-Series and parallel reduction<br>Introduction to AC circuits– Alternating current and Voltage-RMS and average values of sinusoidal waveforms-Power-real power, reactive power and Power factor. |  |     |
| UNIT II - DC MACHINES                                                                                                                                                                                                                                                         |  | (9) |
| DC Generator: Construction, Types, Principle of operation, EMF equation, Characteristics. DC Moto<br>Principle of operation, Types, Torque equation, Characteristics and Applications.                                                                                        |  |     |
| UNIT III - AC MACHINES                                                                                                                                                                                                                                                        |  | (9) |
| Single phase induction motor: Construction, Types, working principle- Three phase induction moto<br>Construction, Types, Torque – Slip Characteristics- Synchronous motor: Construction, working principle.                                                                   |  |     |
| UNIT IV - TRANSFORMERS                                                                                                                                                                                                                                                        |  | (9) |
| Construction, Types, Principle of operation, EMF Equation and applications.                                                                                                                                                                                                   |  |     |
| UNIT V - ELECTRICAL DRIVES AND ITS APPLICATIONS                                                                                                                                                                                                                               |  | (9) |
| Introduction - Selection of electric drive – types of DC and AC drives, Case study: Speed control in Electric vehicle and paper mills.                                                                                                                                        |  |     |
| TOTAL (L:45) : 45 PERIOD                                                                                                                                                                                                                                                      |  |     |

**TEXT BOOK:**

1. D P Kothari and I.J Nagarath, "Basic Electrical Engineering", McGraw Hill Education (India) Private Limited, 4th Edition, 2019.
2. Dubey G.K., "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2nd edition, Reprint 2020

**REFERENCES:**

1. Mittle and V. N. Mittle, "Basic Electrical Engineering", Tata McGraw Hill Edition, New Delhi, 2005
2. Krishnan R, Electric Motor Drives: Modeling, Analysis and Controll, Pearson India, 2015

| COs             | POs      |          |   |   |   |   |   |          |          |          |          | PSOs     |   |
|-----------------|----------|----------|---|---|---|---|---|----------|----------|----------|----------|----------|---|
|                 | 1        | 2        | 3 | 4 | 5 | 6 | 7 | 8        | 9        | 10       | 11       | 1        | 2 |
| 1               | 3        |          |   |   |   |   |   |          |          |          |          | 2        |   |
| 2               | 3        |          |   |   |   |   |   |          |          |          |          | 2        |   |
| 3               |          | 3        |   |   |   |   |   |          |          |          |          | 2        |   |
| 4               | 3        |          |   |   |   |   |   |          |          |          |          | 2        |   |
| 5               |          |          |   |   |   |   |   | 3        | 3        | 3        | 3        |          |   |
| <b>CO (W.A)</b> | <b>3</b> | <b>3</b> |   |   |   |   |   | <b>3</b> | <b>3</b> | <b>3</b> | <b>3</b> | <b>2</b> |   |

G. R. S.

| 22MEC02 - ENGINEERING GRAPHICS AND DRAFTING                                                                                                                                                                                                               |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|-----|
|                                                                                                                                                                                                                                                           |                                                                                                                                                                                                | L                                                                                                                                                                                                                                                                                                                                                                            | T                                            | P | C   |
|                                                                                                                                                                                                                                                           |                                                                                                                                                                                                | 3                                                                                                                                                                                                                                                                                                                                                                            | 0                                            | 2 | 4   |
| PREREQUISITE : NIL                                                                                                                                                                                                                                        |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   |     |
| Course Objective:                                                                                                                                                                                                                                         |                                                                                                                                                                                                | <ul style="list-style-type: none"><li>• To Create the projection of points, lines and planes</li><li>• To Develop the projection of Solid</li><li>• To Solve problems in sectioning of solids and developing the surfaces</li><li>• To Apply the concepts of orthographic and isometric</li><li>• To Draw engineering drawing by Modeling software with dimensions</li></ul> |                                              |   |     |
| Course Outcomes<br>The Student will be able to                                                                                                                                                                                                            |                                                                                                                                                                                                | Cognitive Level                                                                                                                                                                                                                                                                                                                                                              | Weightage of COs in End Semester Examination |   |     |
| CO1                                                                                                                                                                                                                                                       | Draw projections of points in any quadrant, apply first angle projection to find true length and inclinations of lines, and construct projections of planes inclined to both principal planes. | Ap                                                                                                                                                                                                                                                                                                                                                                           | 40%                                          |   |     |
| CO2                                                                                                                                                                                                                                                       | Apply drawing standards to project solids using manual and CAD tools.                                                                                                                          | Ap                                                                                                                                                                                                                                                                                                                                                                           | 20%                                          |   |     |
| CO3                                                                                                                                                                                                                                                       | Apply drawing standards to develop lateral surfaces of solids using manual and CAD tools.                                                                                                      | Ap                                                                                                                                                                                                                                                                                                                                                                           | 20%                                          |   |     |
| CO4                                                                                                                                                                                                                                                       | Apply drawing standards to draw isometric views and sketch orthographic projections using manual and CAD tools.                                                                                | An                                                                                                                                                                                                                                                                                                                                                                           | 20%                                          |   |     |
| CO5                                                                                                                                                                                                                                                       | Engage independent study and make effective oral presentation on engineering graphics                                                                                                          | U                                                                                                                                                                                                                                                                                                                                                                            | Internal Assessment                          |   |     |
| CONCEPTS AND CONVENTIONS (Not for Examination)                                                                                                                                                                                                            |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   |     |
| Importance of graphics in engineering applications - use of drafting instruments - BIS conventions and specifications - size, layout and folding of drawing sheets - lettering and dimensioning - scales.                                                 |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   |     |
| UNIT I- PROJECTION OF POINTS AND LINES                                                                                                                                                                                                                    |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   | (9) |
| Principal planes - first angle projection - projection of points - projection of straight lines (only first angle projections) inclined to both the principal planes - determination of true lengths and true inclinations by rotating line method.       |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   |     |
| UNIT II - FIRST ANGLE PROJECTION OF PLANE                                                                                                                                                                                                                 |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   | (9) |
| Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.                                                                                                                                   |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   |     |
| UNIT III - PROJECTION OF SOLIDS                                                                                                                                                                                                                           |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   | (9) |
| Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to anyone of the principal plane and Parallel to another by rotating object method.                                                                        |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   |     |
| UNIT IV - DEVELOPMENT OF SURFACES                                                                                                                                                                                                                         |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   | (9) |
| Development of lateral surfaces of simple and sectioned solids - prisms, pyramids cylinder and cone.                                                                                                                                                      |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   |     |
| UNIT V – ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS                                                                                                                                                                                                           |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   | (9) |
| Principles of isometric projection - isometric scale - isometric projections of lines, plane figures, simple solid and truncated solids - prisms, pyramids, cylinders, cones – free hand sketching of orthographic views from isometric views of objects. |                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                              |                                              |   |     |

**LIST OF THE EXPERIMENTS**

1. Computer aided drafting of front and top views of the given isometric view.
2. Computer aided drafting of front and top views of cylinder and cone.
3. Computer aided drafting of sectional views of prism and pyramid.
4. Draw the isometric projection from given front and top views of the solid model.
5. 3D modeling of prism and pyramid
6. 3D modeling of spur gear.

TOTAL (L:45+P30) : 75 PERIODS

**TEXT BOOKS:**

1. K.Venugopal and V.Prabhu Raja, "Engineering Graphics", New Age International (P) Limited, 2022.
2. N.S Parthasarathy and Vela Murali, "Engineering Drawing", Oxford University Press, 2015.

**REFERENCES:**

1. N.D.Bhatt and V.M.Panchal, "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2014.
2. K.R.Gopalakrishna., "Computer Aided Engineering Drawing" (Vol I and II combined) Subhas Stores, Bangalore, 2017.
3. K. V.Natarajan, "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.
4. Luzzader, Warren.J., and Duff, John M, "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production", Eastern Economy Edition, Prentice Hall of India Pvt Ltd, New Delhi, 2005.
5. M.B.Shah and B.C.Rana, "Engineering Drawing", Pearson, 2nd Edition, 2009.

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        | 3   |   |   | 3 |   |   |   |   |   |    |    | 3    | 2 |
| 2        | 3   |   |   | 3 | 3 |   |   |   |   |    |    | 3    | 2 |
| 3        | 3   |   |   | 3 | 3 |   |   |   |   |    |    | 3    | 2 |
| 4        | 3   |   |   | 3 | 3 |   |   |   |   |    |    | 3    | 2 |
| 5        |     |   |   | 3 | 3 |   |   | 2 | 3 |    | 1  | 3    | 2 |
| CO (W.A) | 3   |   |   | 3 | 3 |   |   | 2 | 3 |    | 1  | 3    | 2 |

| <b>22GEP01 - ENGINEERING PRACTICES LABORATORY</b><br>(Common to AGRI, BME, CHEM, CIVIL, ECE, EEE and MECH Branches) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |                        |          |
|---------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------------------------|----------|
|                                                                                                                     | <b>L</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>T</b> | <b>P</b>               | <b>C</b> |
|                                                                                                                     | <b>0</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>0</b> | <b>4</b>               | <b>2</b> |
| <b>PREREQUISITE : NIL</b>                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |                        |          |
| <b>Course Objective:</b>                                                                                            | <ul style="list-style-type: none"> <li>To provide hands on training on various basic engineering practices in civil engineering</li> <li>To provide hands on training on welding in mechanical engineering</li> <li>To provide hands on training on various basic engineering practices in mechanical engineering</li> <li>To understand the basic working principle of electric components</li> <li>To understand the basic working principle of electronic components</li> </ul> |          |                        |          |
| <b>Course Outcomes</b><br>The Student will be able to                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          | <b>Cognitive Level</b> |          |
| CO1                                                                                                                 | Design new layouts of civil work for residential and industrial buildings.                                                                                                                                                                                                                                                                                                                                                                                                         |          | Ap                     |          |
| CO2                                                                                                                 | Apply the concepts of welding in repairing works and making various components                                                                                                                                                                                                                                                                                                                                                                                                     |          | Ap                     |          |
| CO3                                                                                                                 | Design new components using machining processes in real life and industries                                                                                                                                                                                                                                                                                                                                                                                                        |          | Ap                     |          |
| CO4                                                                                                                 | Apply the skills of basic electrical engineering for wiring in different areas and Measure various electrical quantities                                                                                                                                                                                                                                                                                                                                                           |          | Ap                     |          |
| CO5                                                                                                                 | Apply electronic principles to measure various parameters of a signal.                                                                                                                                                                                                                                                                                                                                                                                                             |          | Ap                     |          |

| <b>GROUP-A (MECHANICAL AND CIVIL ENGINEERING)</b>                                                                                                                   |             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>I - CIVIL ENGINEERING PRACTICE</b>                                                                                                                               | <b>(15)</b> |
| <b>Buildings:</b><br>a. Study of plumbing and carpentry components of residential and industrial buildings, Safety aspects                                          |             |
| <b>Plumbing:</b><br>a. Study of tools and operations<br>b. Hands-on-exercise: External thread cutting and joining of pipes                                          |             |
| <b>Carpentry:</b><br>a. Study of tools and operations<br>b. Hands-on-exercise: "L" joint and "T" joint                                                              |             |
| <b>II - MECHANICAL ENGINEERING PRACTICE</b>                                                                                                                         | <b>(15)</b> |
| <b>Welding:</b><br>a. Study of arc welding, gas welding tools and equipments<br>b. Arc welding- Butt joints, Lap joints and Tee joints<br>c. Practicing gas welding |             |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>Basic Machining:</b> <ol style="list-style-type: none"> <li>Study of lathe and drilling machine</li> <li>Facing and turning</li> <li>Drilling and Tapping</li> </ol>                                                                                                                                                                                                                                                                                                                                                   |             |
| <b>Sheet Metal Work:</b> <ol style="list-style-type: none"> <li>Study of tools and operations</li> <li>Rectangular tray</li> <li>Cone</li> </ol>                                                                                                                                                                                                                                                                                                                                                                          |             |
| <b>GROUP - B (ELECTRICAL AND ELECTRONICS)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |             |
| <b>I - ELECTRICAL ENGINEERING PRACTICE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>(15)</b> |
| <ol style="list-style-type: none"> <li>Residential house wiring using Switches ,fuse, indicator, lamp</li> <li>Fluorescent lamp wiring</li> <li>Stair Case Wiring</li> <li>Measurement of electrical quantities – Voltage, current ,power in R Circuit</li> <li>Study of Electrical apparatus-Iron box &amp; water heater</li> <li>Study of Electrical Measuring instruments- Megger</li> </ol>                                                                                                                           |             |
| <b>II - ELECTRONICS ENGINEERING PRACTICE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>(15)</b> |
| <ol style="list-style-type: none"> <li>Study of Electronic components and various use of multi meter.</li> <li>Measurement of AC signal parameter (peak-peak, RMS period, frequency) using CRO.</li> <li>Study of logic gates AND, OR, XOR and NOT.</li> <li>Study of Clock Signal.</li> <li>Soldering practice -Components Devices and Circuits - Using general purpose PCB.</li> <li>Study of Half Wave Rectifier (HWR) and Full Wave Rectifier (FWR).</li> <li>Study of Telephone, FM Radio and Cell Phone.</li> </ol> |             |
| <b>TOTAL (P: 60) = 60 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |

| Mapping of COs with POs / PSOs |          |          |          |   |   |   |   |   |   |    |    |          |   |
|--------------------------------|----------|----------|----------|---|---|---|---|---|---|----|----|----------|---|
| COs                            | POs      |          |          |   |   |   |   |   |   |    |    | PSOs     |   |
|                                | 1        | 2        | 3        | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1        | 2 |
| 1                              | 3        |          |          |   |   |   |   |   |   |    |    |          |   |
| 2                              |          | 3        |          |   |   |   |   |   |   |    |    |          |   |
| 3                              |          |          | 2        |   |   |   |   |   |   |    |    |          |   |
| 4                              | 3        |          |          |   |   |   |   |   |   |    |    | 1        |   |
| 5                              | 3        |          |          |   |   |   |   |   |   |    |    | 1        |   |
| <b>CO (W.A)</b>                | <b>3</b> | <b>3</b> | <b>2</b> |   |   |   |   |   |   |    |    | <b>1</b> |   |





| 22CYP01 - CHEMISTRY LABORATORY<br>(Common to AGRI, BME, CHEM, CIVIL, ECE, EEE and MECH Branches)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                               |   |                 |    |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------|----|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                               | L | T               | P  | C |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                               | 0 | 0               | 2  | 1 |
| PREREQUISITE : NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                               |   |                 |    |   |
| Course Objective:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <ul style="list-style-type: none"><li>To determine the copper in brass in the given solution and explain the origin of hardness, alkalinity, chloride and dissolved oxygen in water.</li><li>To perform a potentiometric, conductometric titration and pH of an acidic solution of known Normality.</li></ul> |   |                 |    |   |
| Course Outcomes<br>The Student will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                               |   | Cognitive Level |    |   |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Predict the various water quality parameters by volumetric analysis.                                                                                                                                                                                                                                          |   |                 | An |   |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Evaluate the amount of copper in the given solution by titration method.                                                                                                                                                                                                                                      |   |                 | E  |   |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Analyze the conductance and emf of the different solutions.                                                                                                                                                                                                                                                   |   |                 | An |   |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Analyze and gain experimental skill about potential of hydrogen ion.                                                                                                                                                                                                                                          |   |                 | An |   |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Examine the pH of various acidic, basic and neutral solutions.                                                                                                                                                                                                                                                |   |                 | An |   |
| LIST OF EXPERIMENTS :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                               |   |                 |    |   |
| <ol style="list-style-type: none"><li>Determination of total, temporary &amp; permanent hardness of water by EDTA method.</li><li>Determination of alkalinity in water sample.</li><li>Determination of chloride content of water sample by Argentometric method.</li><li>Determination of DO content of water sample by Winkler's method.</li><li>Estimation of copper in brass by EDTA.</li><li>Conductometric titration of strong acid vs strong base.</li><li>Estimation of iron content of the given solution using potentiometer.</li><li>Determination of strength of given hydrochloric acid using pH meter.</li></ol> |                                                                                                                                                                                                                                                                                                               |   |                 |    |   |
| Total (30 P) = 30 periods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |   |                 |    |   |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              |     |   |   |   | 3 |   |   |   |   |    |    |      |   |
| 2                              |     |   |   |   |   | 2 |   |   |   |    |    |      |   |
| 3                              |     |   |   |   |   | 2 |   |   |   |    |    |      |   |
| 4                              |     |   |   |   | 3 |   |   |   |   |    |    |      |   |
| 5                              |     |   |   |   |   | 2 |   |   |   |    |    |      |   |
| CO (W.A)                       |     |   |   |   | 3 | 2 |   |   |   |    |    |      |   |

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| 22MAN03 - YOGA – I<br>(Common to All Branches)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>L</b>               | <b>T</b>                                            | <b>P</b> |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>0</b>               | <b>0</b>                                            | <b>1</b> |
| <b>PREREQUISITE : NIL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |          |
| <b>Course Objective:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>To make students in understanding the importance of yoga in shaping mental and physical wellness.</li> <li>To provide awareness about the significance of leading a peaceful life by following yoga exercises and principles.</li> <li>To develop mental wellbeing through meditation and breathing exercises.</li> <li>To strengthen the body through physical exercises.</li> <li>To inculcate the knowledge about different types of Asanas and their benefits</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Understand the importance of yoga for physical and mental goodness.                                                                                                                                                                                                                                                                                                                                                                                                                                                 | U                      | Internal Assessment                                 |          |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Perform the yoga exercises for hand, leg, eye and sun salutation etc.                                                                                                                                                                                                                                                                                                                                                                                                                                               | Ap                     |                                                     |          |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Learn and practice meditation techniques for keeping good mental health                                                                                                                                                                                                                                                                                                                                                                                                                                             | Ap                     |                                                     |          |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Develop their body by performing yoga exercises.                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Ap                     |                                                     |          |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Demonstrate different types of yoga Asanas for improving their personal fitness.                                                                                                                                                                                                                                                                                                                                                                                                                                    | Ap                     |                                                     |          |
| <b>UNIT I – INTRODUCTION TO YOGA</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     | (3)      |
| Meaning and Importance of Yoga - Elements of Yoga - Introduction - Asanas, Pranayama, Meditation and Yogic Kriyas - Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana and Shashankasana) - Relaxation Techniques for improving concentration - Yog-nidra.                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |          |
| <b>UNIT II - YOGA AND LIFE STYLE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     | (3)      |
| Asanas as Preventive measures – Hypertension:Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana – Obesity: Procedure, Beneits and contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana – Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana - Diabetes: Procedure, Benefits and contraindications for Bhujangasana, Paschimottasana, Pavan Muktasana, Ardh Matsyendrasana – Asthema: Procedure, Benfits and contraindications for Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |          |
| <b>UNIT III – MIND EXERCISES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     | (3)      |
| Naadi sudhi – Thanduvada sudhi – Breathing meditation – Silent meditation – Relax meditation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |          |
| <b>UNIT IV – PHYSICAL EXERCISES (PART– I)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     | (3)      |
| Hand Exercises – Leg Exercises – Eye Exercises – Sun Salutation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |          |

|                                                                                                             |            |
|-------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT V – ASANAS (PART-I)</b>                                                                             | <b>(3)</b> |
| Asanas –Tadasana – Yegapadhasana – Chakrasana – Udkaddasana – Thirikosana – Thandasana – Paschimottanasana. |            |
| <b>TOTAL (P:15) : 15 PERIODS</b>                                                                            |            |

|                                     |
|-------------------------------------|
| <b>TEXT BOOKS/REFERENCES:</b>       |
| I. Light On Yoga by B.K.S. Iyengar. |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              |     |   |   |   |   |   | 3 | 2 |   |    | 3  |      |   |
| 2                              |     |   |   |   |   |   | 3 | 2 |   |    | 3  |      |   |
| 3                              |     |   |   |   |   |   | 3 | 2 |   |    | 3  |      |   |
| 4                              |     |   |   |   |   |   | 3 | 2 |   |    | 3  |      |   |
| 5                              |     |   |   |   |   |   | 3 | 2 |   |    | 3  |      |   |
| <b>CO (W.A)</b>                |     |   |   |   |   |   | 3 | 2 |   |    | 3  |      |   |

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| 22EYA02 - PROFESSIONAL COMMUNICATION - II<br>(Common to All Branches) |                                                                                                                               |                                                                                                                                                                                                 |                 |                                              |   |   |
|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                                       |                                                                                                                               |                                                                                                                                                                                                 | L               | T                                            | P | C |
|                                                                       |                                                                                                                               |                                                                                                                                                                                                 | 2               | 0                                            | 2 | 3 |
| PREREQUISITE : 22EYA01                                                |                                                                                                                               |                                                                                                                                                                                                 |                 |                                              |   |   |
| Course Objective:                                                     |                                                                                                                               | <ul style="list-style-type: none"><li>• To enhance the students with necessary English language skills</li><li>• To enable students to communicate effectively in an academic setting</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to                        |                                                                                                                               |                                                                                                                                                                                                 | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                                                   | Frame sentences both in written and spoken forms with accuracy and fluency.                                                   |                                                                                                                                                                                                 | R               | 20%                                          |   |   |
| CO2                                                                   | Use linguistic structures to read and understand well-structured texts encountered in academic or social contexts.            |                                                                                                                                                                                                 | U               | 20%                                          |   |   |
| CO3                                                                   | Gain essential competency to express one's thoughts orally and in writing in a meaningful way.                                |                                                                                                                                                                                                 | U               | 20%                                          |   |   |
| CO4                                                                   | Attain and enhance competence in the four modes of literacy: Listening, Speaking, Reading and Writing.                        |                                                                                                                                                                                                 | Ap              | 20%                                          |   |   |
| CO5                                                                   | Perform various tasks, such as role plays, debates, group discussions apart from the use of correct spelling and punctuation. |                                                                                                                                                                                                 | U               | 20%                                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <b>UNIT I - LANGUAGE RUDIMENTS</b>                                                                                                                                                                                                                                                                                                                                                                             | (6+6) |
| Grammar – Active and Passive Voice – Impersonal Passive Voice – Numerical Expressions - Listening – Listening for Specific Information and Match / Choose / Fill in the texts - Speaking – Describing a Person - Making Plans -Reading – Intensive Reading -Writing – Job Application with Resume                                                                                                              |       |
| <b>UNIT II - RHETORIC ENHANCERS</b>                                                                                                                                                                                                                                                                                                                                                                            | (6+6) |
| Grammar – Reported Speech – Infinitive and Gerund - Listening – Listening to Iconic Speeches and making notes - Listening news / documentaries - Speaking –Talking over Phone – Narrating Incidents - Reading – Extensive Reading (Motivational Books) - Writing – Recommendation                                                                                                                              |       |
| <b>UNIT III - TECHNICAL CORRESPONDENCE</b>                                                                                                                                                                                                                                                                                                                                                                     | (6+6) |
| Grammar – If Conditionals – Blended Words - Listening – Listening to business conversation on audio and video of Short Films, News, Biographies - Speaking – Synchronous communication and Asynchronous communication - Opportunities and threats in using digital platform- Reading - Finding key information in a given text - Writing –Netiquettes- Inviting Dignitaries - Accepting & Declining Invitation |       |
| <b>UNIT IV - CORPORATE COMMUNICATION</b>                                                                                                                                                                                                                                                                                                                                                                       | (6+6) |
| Grammar – Concord – Compound Words - Listening – Listening to Roles and Responsibilities in Corporate - Listening to technical videos - Speaking – Introduction to Technical Presentation - Story Telling - Reading – Reading and Understanding Technical Articles - Writing – Report Writing (Accident, Survey and feasibility)                                                                               |       |

|                                                                                                                                                                                                                                                                                             |       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <b>UNIT V - LANGUAGE BOOSTERS</b>                                                                                                                                                                                                                                                           | (6+6) |
| Grammar - Idiomatic Expressions – Relative Clauses – Confusable words - Listening – Listening to different kinds of Interviews - Listening to Group Discussion - Speaking – Group Discussion - Reading – Reading and Interpreting Visual Materials - Writing – Analytical Paragraph Writing |       |
| <b>LIST OF SKILLS ASSESSED IN THE LABORATORY</b>                                                                                                                                                                                                                                            |       |
| <b>1. Grammar</b><br><b>2. Listening Skills</b><br><b>3. Speaking Skills</b><br><b>4. Reading Skills</b><br><b>5. Writing Skills</b>                                                                                                                                                        |       |
| <b>TOTAL (L:30 , P:30 ) = 60 PERIODS</b>                                                                                                                                                                                                                                                    |       |

|                                                                                                                                                                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                             |
| 1. Sudharshana, N.P and Saveetha.C. <i>English for Technical Communication</i> . Cambridge University Press, New Delhi, 2016 (Reprint 2017).                                   |
| <b>REFERENCES:</b>                                                                                                                                                             |
| 1. Rizvi, M Ashraf. <i>Effective Technical Communication</i> . Second Edition, McGraw Hill Education India PvtLtd, 2017.                                                       |
| 2. Rodney Huddleston, Geoffrey K. Pullum and Brett Reynolds. <i>A Student's Introduction to English Grammar</i> . Second Edition, Cambridge University Press, New Delhi, 2022. |
| <b>WEB REFERENCE:</b>                                                                                                                                                          |
| 1. <a href="http://youtu.be/URtdGiutVew">http://youtu.be/URtdGiutVew</a>                                                                                                       |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |          |          |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|----------|----------|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |          |          |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8        | 9        | 10 | 11 | 1    | 2 |
| 1                              |     |   |   |   |   |   |   | 2        | 3        |    |    |      |   |
| 2                              |     |   |   |   |   |   |   | 2        | 3        |    |    |      |   |
| 3                              |     |   |   |   |   |   |   | 2        | 3        |    |    |      |   |
| 4                              |     |   |   |   |   |   |   | 2        | 3        |    |    |      |   |
| 5                              |     |   |   |   |   |   |   | 2        | 3        |    |    |      |   |
| <b>CO (W.A)</b>                |     |   |   |   |   |   |   | <b>2</b> | <b>3</b> |    |    |      |   |

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| 22MYB02 – PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORM TECHNIQUES<br>(Common to AGRI, CIVIL, CHEMICAL and MECH Branches) |                                                                                                                                                                                                                                                                                                                                         |                        |                                                     |          |
|--------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                                                                                          |                                                                                                                                                                                                                                                                                                                                         | <b>L</b>               | <b>T</b>                                            | <b>P</b> |
|                                                                                                                          |                                                                                                                                                                                                                                                                                                                                         | <b>3</b>               | <b>1</b>                                            | <b>0</b> |
| <b>PREREQUISITE : NIL</b>                                                                                                |                                                                                                                                                                                                                                                                                                                                         |                        |                                                     |          |
| <b>Course Objective:</b>                                                                                                 | <ul style="list-style-type: none"> <li>To make the conversant with concepts of Laplace transforms, Fourier series, Fourier Transforms to represent periodical physical problems in engineering analysis.</li> <li>To provide adequate knowledge in partial differential equation and to analyze the boundary value problems.</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to                                                                    |                                                                                                                                                                                                                                                                                                                                         | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                                                                                      | Apply the various techniques of Fourier series to obtain solution for different functions.                                                                                                                                                                                                                                              | Ap                     | 20%                                                 |          |
| CO2                                                                                                                      | Interpret the methods of partial differential equations in fluid mechanics and water resource management.                                                                                                                                                                                                                               | Ap                     | 20%                                                 |          |
| CO3                                                                                                                      | Solve the initial and boundary value problems by using Fourier series.                                                                                                                                                                                                                                                                  | Ap                     | 20%                                                 |          |
| CO4                                                                                                                      | Analyze the concepts of Transform Techniques to solve the problems in stability analysis, Structural Analysis, control system design and analysis.                                                                                                                                                                                      | An                     | 40%                                                 |          |
| CO5                                                                                                                      | Demonstrate the importance of Transform Techniques and partial differential equations in engineering using modern tools.                                                                                                                                                                                                                | Ap                     | Internal Assessment                                 |          |

|                                                                                                                                                                                                                                                                                                                                                                 |              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>UNIT I – FOURIER SERIES</b>                                                                                                                                                                                                                                                                                                                                  | <b>(9+3)</b> |
| Dirichlet's condition – Fourier series: Half range sine series – Half range cosine series – Parseval's identity for half range series – Root mean square value of a function – Harmonic analysis.                                                                                                                                                               |              |
| <b>UNIT II –PARTIAL DIFFERENTIAL EQUATIONS</b>                                                                                                                                                                                                                                                                                                                  | <b>(9+3)</b> |
| Formulation of partial differential equations by eliminating arbitrary constants and functions – Solution of standard types first order partial differential equations of the type $f(p,q)=0$ , Clairaut's form – Lagrange's linear equations – Linear partial differential equation of second and higher order with constant coefficient of homogeneous types. |              |
| <b>UNIT III –APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS</b>                                                                                                                                                                                                                                                                                                 | <b>(9+3)</b> |
| Classification of second order quasi linear partial differential equations – Solution of one dimensional wave equation (Zero and non-zero velocity) – One dimensional heat equation (Temperature reduced to zero and non zero boundary conditions) – Steady state solution of two dimensional heat equation (Finite and infinite plate).                        |              |

|                                                                                                                                                                                                                                                                                                                                                             |              |
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| <b>UNIT IV –FOURIER TRANSFORM</b>                                                                                                                                                                                                                                                                                                                           | <b>(9+3)</b> |
| Fourier integral theorem(Statement only) – Fourier transform pair - Sine and Cosine transforms – Properties -Transforms of simple functions – Convolution theorem – Parseval's identity(Excluding proof).                                                                                                                                                   |              |
| <b>UNIT V –LAPLACE TRANSFORM</b>                                                                                                                                                                                                                                                                                                                            | <b>(9+3)</b> |
| Condition for existence - Transforms of Elementary functions –Basic Properties- First & Second Shifting Theorems(Statement only) - Initial and Final value Theorems. Inverse Laplace transforms -Convolution theorem (Excluding proof)- Solution of linear second order ordinary differential equations with constant coefficients using Laplace transform. |              |
| <b>TOTAL (L:45+T:15) : 60 PERIODS</b>                                                                                                                                                                                                                                                                                                                       |              |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <ol style="list-style-type: none"> <li>1. Veerarajan.T,"Engineering Mathematics (for semester III), 3rd ed., Tata McGraw Hill, New Delhi.</li> <li>2. Kandasamy.P, Thilagavathy.K, and Gunavathy.K., "Engineering Mathematics; Volume III", S.Chand&amp;Coltd., 2008.</li> <li>3. GrewalB.S,"Higher Engineering Mathematics", 42nd ed., Khanna publishers, New Delhi, 2012.</li> </ol>                                                               |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <ol style="list-style-type: none"> <li>1. Goyal Manish and Bali.N.P,"A Text book of Engineering mathematics", 6th ed.,Laxmi Publication (P) Ltd,New Delhi, 2012.</li> <li>2. Kreyszig, Erwin,"Advanced Engineering Mathematics", 9th ed., Wiley Publications, New Delhi, 2006.</li> </ol> <p style="text-align: center;">Singaravelu.A,"Transforms and Partial Differential Equations", Reprint Edition 2013, Meenakshi Publications, Tamilnadu.</p> |

| <b>Mapping of COs with POs / PSO</b> |            |          |          |          |          |          |          |          |          |           |           |             |          |
|--------------------------------------|------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-------------|----------|
| <b>COs</b>                           | <b>POs</b> |          |          |          |          |          |          |          |          |           |           | <b>PSOs</b> |          |
|                                      | <b>1</b>   | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>1</b>    | <b>2</b> |
| <b>1</b>                             |            | 2        |          |          |          |          |          |          |          |           |           |             |          |
| <b>2</b>                             | 3          |          |          |          |          |          |          |          |          |           |           |             |          |
| <b>3</b>                             | 3          |          |          |          |          |          |          |          |          |           |           |             |          |
| <b>4</b>                             | 3          |          |          |          |          |          |          |          |          |           |           |             |          |
| <b>5</b>                             | 3          |          |          |          | 2        |          |          | 3        |          |           | 3         |             |          |
| <b>CO (W.A)</b>                      | 3          | 2        |          |          | 2        |          |          | 3        |          |           | 3         |             |          |

M. 48



| 22PYB04 - PHYSICS FOR MECHANICAL ENGINEERING          |                                                                                                                                                                                                                                          |                        |                                                     |          |
|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                       |                                                                                                                                                                                                                                          |                        | <b>L</b>                                            | <b>T</b> |
|                                                       |                                                                                                                                                                                                                                          |                        | <b>P</b>                                            | <b>C</b> |
|                                                       |                                                                                                                                                                                                                                          |                        | <b>3</b>                                            | <b>0</b> |
|                                                       |                                                                                                                                                                                                                                          |                        | <b>0</b>                                            | <b>3</b> |
| <b>PREREQUISITE: NIL</b>                              |                                                                                                                                                                                                                                          |                        |                                                     |          |
| <b>Course Objective:</b>                              | <ul style="list-style-type: none"> <li>•To update the knowledge about the properties of matter and elements of thermodynamics.</li> <li>•To identify knowledge in the field of electromagnetic theory and optics &amp; laser.</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The student will be able to |                                                                                                                                                                                                                                          | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                   | Study the bending moment in beams to understand the stress distribution in different beam designs.                                                                                                                                       | An                     | 20%                                                 |          |
| CO2                                                   | Distinguish between different types of materials based on their thermal properties.                                                                                                                                                      | An                     | 20%                                                 |          |
| CO3                                                   | Equipped with a comprehensive perceptive of thermodynamic principles and their practical applications across various engineering and scientific disciplines.                                                                             | Ap                     | 20%                                                 |          |
| CO4                                                   | Demonstrate concepts of electromagnetic waves and solve problems using Maxwell's equations.                                                                                                                                              | An                     | 20%                                                 |          |
| CO5                                                   | Assess the advantages and limitations of laser technology in industrial applications.                                                                                                                                                    | E                      | 20%                                                 |          |

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| <b>UNIT I – PROPERTIES OF MATTER</b>                                                                                                                                                                                                                                                                                                                                                                       | <b>(9)</b> |
| Elasticity – Hooke's law Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment - I-shaped girders - stress due to bending in beams. |            |
| <b>UNIT II – THERMAL PHYSICS</b>                                                                                                                                                                                                                                                                                                                                                                           | <b>(9)</b> |
| Mode of heat transfer-thermal conductivity - Newton's law of cooling - thermal conduction through compound media (bodies in series and parallel) - thermal conductivity of a good conductor – Forbe's method-thermal conductivity of bad conductor - Lee's disc - radial flow of heat-expression for thermal conductivity of rubber - experimental determination - practical applications of conduction.   |            |
| <b>UNIT III – ELEMENTS OF THERMODYNAMICS</b>                                                                                                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Concept of temperature – Heat - Thermodynamics - work – Heat in Thermodynamics – Comparison of heat and work – internal energy - first law of thermodynamics – applications of first law - second law of thermodynamics – the Carnot engine – heat engine – heat pump refrigerator -Third law of thermodynamics.                                                                                           |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT IV – ELECTRO MAGNETIC THEORY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>(9)</b> |
| Force on a moving Charge - Force on a differential Current Element - Force & Torque Magnetisation & Permeability - Magnetic Boundary Conditions -Inductance & Mutual Inductance - Time Varying Fields: Faraday's Law - Displacement Current - Maxwell's Equation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |
| <b>UNIT V – OPTICS AND LASERS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>(9)</b> |
| Interference: Air wedge – theory – uses – testing of flat surfaces – determination of thickness of a thin wire – Introduction of laser - Properties of laser beams : mono - chromaticity, coherence, directionality and Intensity - Einstein's A and B coefficients derivation - Resonant cavity - Types of lasers – solid state laser (Neodymium) – Gas laser (CO <sub>2</sub> ) – Materials processing – Laser Cutting – Drilling – Welding – Soldering – Industrial Applications.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |            |
| <b>TOTAL (L: 45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |
| <b>TEXT BOOKS</b> <ol style="list-style-type: none"> <li>1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2019.</li> <li>2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ.Press, 2017.</li> <li>3. A. Marikani, "Materials Science", PHI Learning Private Limited, Eastern Economy Edition, 2019.</li> </ol> <b>REFERENCES</b> <ol style="list-style-type: none"> <li>1. Dattuprasad and Ramanlal Joshi, "Engineering Physics" Tata McGraw hill education, 2016.</li> <li>2. Subrahmanyam N, Brijlal, "A Text Book of Optics" S.Chand &amp; Co. Ltd, New Delhi, 2017.</li> <li>3. M.N.Avathanalu, P.G.Kshirsagar "A text book of engineering physics" S.Chand &amp; company Ltd, 2015.</li> </ol> <b>WEB LINKS</b> <ol style="list-style-type: none"> <li>1. <a href="https://bayanbox.ir/view/7764531208313247331/Kleppner-D.-Kolenkow-R.J.-Introduction-to-Mechanics-2014.pdf">https://bayanbox.ir/view/7764531208313247331/Kleppner-D.-Kolenkow-R.J.-Introduction-to-Mechanics-2014.pdf</a>.</li> <li>2. <a href="https://physicaeducator.files.wordpress.com/2017/11/electricity_and_magnetism-by-purcell-3ed-ed.pdf">https://physicaeducator.files.wordpress.com/2017/11/electricity_and_magnetism-by-purcell-3ed-ed.pdf</a>.</li> </ol> |            |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   | 3 | 3 |   |   |   |   | 1 | 1 |    | 2  |      |   |
| 2                              | 3   | 2 | 3 |   |   |   |   | 1 | 1 |    | 1  |      |   |
| 3                              | 3   | 2 | 3 |   |   |   |   | 1 | 1 |    | 2  |      |   |
| 4                              | 2   | 2 | 2 |   |   |   |   |   |   |    | 1  |      |   |
| 5                              | 2   | 1 | 2 |   |   |   |   | 1 | 1 |    | 2  |      |   |
| CO (W.A)                       | 3   | 2 | 3 |   |   |   |   | 1 | 1 |    | 2  |      |   |

| 22CSC01 - PROBLEM SOLVING AND C PROGRAMMING<br>(Common to All Branches) |                                                                                                               |                                                                                                                                                                               |                                                     |          |
|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|----------|
|                                                                         |                                                                                                               | <b>L</b>                                                                                                                                                                      | <b>T</b>                                            | <b>P</b> |
|                                                                         |                                                                                                               | <b>3</b>                                                                                                                                                                      | <b>0</b>                                            | <b>0</b> |
| <b>PREREQUISITE : NIL</b>                                               |                                                                                                               |                                                                                                                                                                               |                                                     |          |
| <b>Course Objectives:</b>                                               |                                                                                                               | <ul style="list-style-type: none"> <li>To equip students with the essential skills and knowledge to solve computational problems using the C programming language.</li> </ul> |                                                     |          |
| <b>Course Outcomes</b><br>The student will be able to                   |                                                                                                               | <b>Cognitive Level</b>                                                                                                                                                        | <b>Weightage of COs in End Semester Examination</b> |          |
| <b>CO1</b>                                                              | Apply basic syntax and semantics of C language to write clear and structured code.                            | Ap                                                                                                                                                                            | 20%                                                 |          |
| <b>CO2</b>                                                              | Make use of both conditional statements and iterative control structures for developing applications.         | Ap                                                                                                                                                                            | 20%                                                 |          |
| <b>CO3</b>                                                              | Apply knowledge of arrays and strings to solve computational problems.                                        | Ap                                                                                                                                                                            | 20%                                                 |          |
| <b>CO4</b>                                                              | Identify modular solutions that integrate problem-solving techniques to solve complex computational problems. | An                                                                                                                                                                            | 20%                                                 |          |
| <b>CO5</b>                                                              | Analyze the performance implications using pointers and to manage file operations efficiently.                | An                                                                                                                                                                            | 20%                                                 |          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I -PROBLEM SOLVING AND C PROGRAMMING BASICS</b>                                                                                                                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| <b>General Problem Solving:</b> Algorithms, Flowcharts and Pseudo-codes, implementation of algorithms<br><b>Basics of C Programming :</b> Introduction to C - Structure of C program - Programming Rules – Compilation – Errors - C Declarations: Tokens - keywords - identifiers - constants - data types - variable declaration and initialization - type conversion - constant and volatile variables - operators and expressions. |            |
| <b>UNIT II - DECISION CONTROL STATEMENTS</b>                                                                                                                                                                                                                                                                                                                                                                                          | <b>(9)</b> |
| Managing Input and Output operations, Decision Control Statements: Decision control statements, Selection/conditional branching Statements: if, if-else, nested if, if-elif-else statements. Basic loop Structures/Iterative statements: while loop, for loop, selecting appropriate loop. Nested loops break and continue statements.                                                                                                |            |
| <b>UNIT III - ARRAYS AND STRINGS</b>                                                                                                                                                                                                                                                                                                                                                                                                  | <b>(9)</b> |
| Introduction to Array - Definition - Array initialization - Characteristics - One Dimensional Array - Array operations -Two dimensional arrays -Strings and String handling functions.                                                                                                                                                                                                                                                |            |
| <b>UNIT IV - FUNCTIONS</b>                                                                                                                                                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Functions: Basics - definition - Elements of User defined Functions - return statement, Function types, Parameter Passing Techniques, Function returning more values - Passing Array to Functions - Recursion - Storage classes.                                                                                                                                                                                                      |            |
| <b>UNIT V - POINTERS AND FILE MANAGEMENT</b>                                                                                                                                                                                                                                                                                                                                                                                          | <b>(9)</b> |
| Pointer concepts - Pointers & Arrays, Structure concepts - Defining, Declaring, Accessing Member Variables, Structure within Structure - Union - File Management in C- Dynamic Memory Allocation                                                                                                                                                                                                                                      |            |
| <b>TOTAL (L:45) :45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                       |            |

**TEXT BOOKS:**

1. Ashok N. Kamthane, "Programming in C", 2nd Edition, Pearson Education, 2013.
2. Sumitabha Das, "Computer Fundamentals and C Programming", 1st Edition, McGraw Hill, 2018.

**REFERENCES:**

1. R. G. Dromey, "How to Solve it by Computer", Pearson Education India; 1st Edition, ISBN10: 8131705625, ISBN-13: 978-8131705629
2. Maureen Spankle, "Problem Solving and Programming Concepts", Pearson; 9th Edition, India, ISBN-10: 9780132492645, ISBN-13: 978- 0132492645
3. Yashavant Kanetkar, "Let us C", 16th Edition, BPB Publications, 2018.
4. ReemaThareja., "Programming in C ", 2nd Edition, Oxford University Press, New Delhi, 2018.
5. Balagurusamy E., "Programming in ANSI C", 7th Edition, Mc Graw Hill Education, 2017.

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   | 2 | 2 |   |   |   |   |   |   | -  | 3  | 3    | 3 |
| 2                              | 3   | 2 | 3 |   |   |   |   |   |   | -  | 3  | 3    | 3 |
| 3                              | 3   | 2 | 3 |   |   |   |   |   |   | 3  | 3  | 3    | 3 |
| 4                              | 3   | 2 | 3 |   |   |   |   | 3 |   | 3  | 3  | 3    | 3 |
| 5                              | 3   | 2 | 3 |   |   |   |   |   |   | 3  | 3  | 3    | 3 |
| CO (W.A)                       | 3   | 2 | 3 |   |   |   |   | 3 |   | 3  | 3  | 3    | 3 |

\* Ratified by Eleventh Academic Council

| 22ECC03- BASICS OF ELECTRONICS AND INSTRUMENTATION ENGINEERING |                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                            |  |                 |   |                                              |   |
|----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----------------|---|----------------------------------------------|---|
|                                                                |                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                            |  | L               | T | P                                            | C |
|                                                                |                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                            |  | 3               | 0 | 0                                            | 3 |
| PREREQUISITE : NIL                                             |                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                            |  |                 |   |                                              |   |
| Course Objective:                                              |                                                                                                                                                   | <ul style="list-style-type: none"><li>• To understand the basic electric laws and basic of electronics.</li><li>• To impart knowledge on the principles of working of semi-conductor circuits, its characteristics and fundamentals of digital electronics.</li><li>• To expound the working principles of measuring and indicating instruments.</li></ul> |  |                 |   |                                              |   |
|                                                                |                                                                                                                                                   | Course Outcomes<br>The Student will be able to                                                                                                                                                                                                                                                                                                             |  | Cognitive Level |   | Weightage of COs in End Semester Examination |   |
| CO1                                                            | Apply the knowledge of theorems/laws to analyze the simple circuits.                                                                              |                                                                                                                                                                                                                                                                                                                                                            |  | Ap              |   | 20%                                          |   |
| CO2                                                            | Apply the basic laws and theorems to analyze the characteristics and operating principles of Semiconductor devices.                               |                                                                                                                                                                                                                                                                                                                                                            |  | Ap              |   | 20%                                          |   |
| CO3                                                            | Apply the fundamental knowledge of Mathematics in digital electronics to define characteristics of logic families and calculate their parameters. |                                                                                                                                                                                                                                                                                                                                                            |  | Ap              |   | 20%                                          |   |
| CO4                                                            | Identify the various parameters that are measurable in electronic instrumentation.                                                                |                                                                                                                                                                                                                                                                                                                                                            |  | Ap              |   | 20%                                          |   |
| CO5                                                            | Analyze the various parameters to employ appropriate instruments to measure given sets of parameters.                                             |                                                                                                                                                                                                                                                                                                                                                            |  | Ap              |   | 20%                                          |   |

|                                                                                                                                                                                                                                                                                                            |            |
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| <b>UNIT I - BASICS OF ELECTRONICS</b>                                                                                                                                                                                                                                                                      | <b>(9)</b> |
| Ohm's law - Kirchhoff's law - Power: real, reactive and apparent - Power factor - Electrical circuit elements(R, L, C) series and parallel circuits - Voltage and current sources - Representation of sinusoidal waveforms- Peak and RMS values- semiconductors-intrinsic, extrinsic, energy band diagram. |            |
| <b>UNIT II - SEMICONDUCTOR CIRCUITS</b>                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| PN junction Diode - forward bias, reverse bias, drift and diffusion current - Rectifier: Half wave, full wave and bridge rectifier - Transistor: PNP, NPN transistor – Operational amplifier: inverting and non-inverting amplifier.                                                                       |            |
| <b>UNIT III - DIGITAL ELECTRONICS</b>                                                                                                                                                                                                                                                                      | <b>(9)</b> |
| Number system: binary, octal, decimal and hexadecimal – Boolean algebra theorems – Logic gates - Flip-flops and types (diagram and truth table) – register and counter (types).                                                                                                                            |            |
| <b>UNIT IV - MEASURING INSTRUMENTS</b>                                                                                                                                                                                                                                                                     | <b>(9)</b> |
| Sensors: static and dynamic characteristics – Transducer – Piezo electric, resistive, inductive, capacitive, thermo electric, photo electric and LVDT.                                                                                                                                                     |            |
| <b>UNIT V - INDICATING INSTRUMENTS</b>                                                                                                                                                                                                                                                                     | <b>(9)</b> |
| Types of indicating instruments: moving coil and moving iron - Error analysis: electrical, mechanical, thermal, optical, biological and chemical classification of errors – Oscilloscopes - Multimeters and Voltmeters.                                                                                    |            |
| <b>TOTAL (L:45) : 45 PERIODS</b>                                                                                                                                                                                                                                                                           |            |

**TEXT BOOKS:**

1. S.Salivahanan, N.Suresh kumar and A.Vallavanraj, "Electronic Devices and Circuits", Tata McGraw Hill, 3rd Edition(2013).
2. Morris Mano M and Michael D.Ciletti, "Digital Design", IV Edition, Pearson Education, 2008
3. Patranabis.D, "Sensor and Transducer", Prentice Hall of India(Pvt)Ltd., 2013.
4. R.Muthusubramanian, S.Salivahanan, "Basic Electrical and Electronics Engineering", Tata McGraw Hill, Nineteenth reprint(2015).

**REFERENCES:**

1. J.B.Gupta, "Electronic Devices and Circuits", S.K.Kataria and Sons, 2009.
2. D.P.Leach, A.P.Malvino, "Digital Principles and Applications",TMH,2010

| Mapping of COs with POs / PSOs |          |          |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|----------|----------|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs      |          |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1        | 2        | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3        |          |   |   |   |   |   |   |   |    |    |      |   |
| 2                              | 3        |          |   |   |   |   |   |   |   |    |    |      |   |
| 3                              | 3        |          |   |   |   |   |   |   |   |    |    |      |   |
| 4                              | 3        |          |   |   |   |   |   |   |   |    |    |      |   |
| 5                              |          | 3        |   |   |   |   |   |   |   |    |    |      |   |
| <b>CO<br/>(W.A)</b>            | <b>3</b> | <b>3</b> |   |   |   |   |   |   |   |    |    |      |   |

| 22MEC03 - ENGINEERING MECHANICS                |                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              |   |   |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                            | L                                                                                                                                                                                                                                                                                                                                                                                                                                                   | T                                            | P | C |
|                                                |                                                                                                                                            | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 1                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              |   |   |
| Course Objective:                              |                                                                                                                                            | <ul style="list-style-type: none"><li>To acquire knowledge on the behaviour of a particle under the action of forces<br/>To analyze the behaviour of the rigid body under the action of forces</li><li>To gain knowledge related to friction and simple contact friction</li><li>To introduce the geometric properties of the different surfaces.</li><li>To acquire knowledge work, energy and momentum related to dynamics of particles</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                            | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                     | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply principles of units, laws of mechanics to solve problems in particles and rigid bodies.                                              | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 20%                                          |   |   |
| CO2                                            | Analyze the statics of rigid bodies in two dimensions and reaction forces of various supports.                                             | An                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 20%                                          |   |   |
| CO3                                            | Evaluate frictional forces, limiting friction, Coulomb's law, and various frictional scenarios such as sliding, ladder, and belt friction. | E                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 20%                                          |   |   |
| CO4                                            | Analyze centroid, center of gravity, moment of inertia using theorems of Pappus and Guldinus, parallel and perpendicular axis theorem.     | An                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 20%                                          |   |   |
| CO5                                            | Evaluate kinematic and kinetic principles, displacement, velocity, acceleration, Newton's laws, and the impact of elastic bodies.          | E                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 20%                                          |   |   |

|                                                                                                                                                                                                                                                                                                                                        |              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>UNIT I - STATICS OF PARTICLE</b>                                                                                                                                                                                                                                                                                                    | <b>(6+3)</b> |
| Units and dimensions - fundamental principles - laws of mechanics, lami's theorem, parallelogram and triangular law of forces, principle of transmissibility – system forces - statics of particles in two dimensions - resultant force - coplanar concurrent forces - Free body diagram - equilibrium of particles in two dimensions. |              |
| <b>UNIT II - STATICS OF RIGID BODY</b>                                                                                                                                                                                                                                                                                                 | <b>(6+3)</b> |
| Statics of rigid body in two dimensions - rigid body - moment of a force about a point - varignon's theorem - resultant force for coplanar parallel and nonconcurrent forces - moments and couples - equilibrium of rigid bodies in two dimensions - requirements of stable equilibrium - types of supports and their reactions.       |              |
| <b>UNIT III - FRICTION</b>                                                                                                                                                                                                                                                                                                             | <b>(6+3)</b> |
| Frictional force – limiting friction - angle of repose - coulomb's law of dry friction - cone of friction - problems involving the equilibrium analysis of simple systems with sliding friction - simple contact friction - ladder friction - belt friction.                                                                           |              |
| <b>UNIT IV - PROPERTIES OF SECTIONS</b>                                                                                                                                                                                                                                                                                                | <b>(6+3)</b> |
| Centroid – centre of gravity- Theorems of Pappus and Guldinus – moment of inertia of plane areas - transfer theorems - parallel axis and perpendicular axis theorem- radius of gyration- product of inertia - polar moment of inertia - principal axes and principal moment of inertia of plane areas.                                 |              |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |              |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>UNIT V - DYNAMICS OF PARTICLES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>(6+3)</b> |
| Kinematics - Displacements, velocity and acceleration, their relationship -rectilinear motion - curvilinear motion - projectile motion.<br>Kinetics - Newton's law – D'Alembert's principle - impact of elastic bodies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |              |
| <b>TOTAL (L:30+T:15): 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |              |
| <b>TEXT BOOKS :</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |              |
| 1. I. Ferdinand P. Beer and E. Russell Johnson, "Vector Mechanics for Engineers: Statics and Dynamics", 12th ed., Tata McGraw Hill International Edition, 2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |              |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |              |
| 1. Irving H. Shames, "Engineering Mechanics : Statics and Dynamics", Prentice Hall of India Private limited, 2006<br>2. Russell C Hibbeler, "Engineering Mechanics: Statics and Dynamics", 14th ed., Prentice Hall, 2016<br>3. Anthony M. Bedford and Wallace Fowler, "Engineering Mechanics: Statics and Dynamics", 5th ed., Prentice Hall, 2008<br>4. Palanichamy, M.S and Nagan,S, "Engineering Mechanics - Statics and Dynamics", 3rd ed., Tata McGraw-Hill, New Delhi, 2005<br>5. Meriam.J.L , Kraige.L.G, and Boltan, J.N "Engineering Mechanics: Statics and Dynamics", 9th ed., Wiley Publishers, 2020<br>6. Rajasekaran.S and Sankarasubramanian.G, "Fundamentals of Engineering Mechanics", 3rd ed., vikas Publishing House Pvt.Ltd. New Delhi, 2005. |              |

| Mapping of COs with POs / PSOs |          |          |          |   |   |   |   |   |   |    |    |          |   |
|--------------------------------|----------|----------|----------|---|---|---|---|---|---|----|----|----------|---|
| COs                            | POs      |          |          |   |   |   |   |   |   |    |    | PSOs     |   |
|                                | 1        | 2        | 3        | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1        | 2 |
| 1                              | 3        |          |          |   |   |   |   |   |   |    |    | 3        |   |
| 2                              |          | 3        |          |   |   |   |   |   |   |    |    | 3        |   |
| 3                              |          | 3        |          |   |   |   |   |   |   |    |    | 3        |   |
| 4                              |          |          | 3        |   |   |   |   |   |   |    |    | 3        |   |
| 5                              |          |          | 3        |   |   |   |   |   |   |    |    |          |   |
| <b>CO (W.A)</b>                | <b>3</b> | <b>3</b> | <b>3</b> |   |   |   |   |   |   |    |    | <b>3</b> |   |



| 22CSP01 - PROBLEM SOLVING AND C PROGRAMMING LABORATORY<br>(Common to All Branches) |                                                                 |                                                                                                                                             |                        |          |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|------------------------|----------|
|                                                                                    |                                                                 | <b>L</b>                                                                                                                                    | <b>T</b>               | <b>P</b> |
|                                                                                    |                                                                 | <b>0</b>                                                                                                                                    | <b>0</b>               | <b>4</b> |
| <b>PREREQUISITE : NIL</b>                                                          |                                                                 |                                                                                                                                             |                        |          |
| <b>Course Objective:</b>                                                           |                                                                 | <ul style="list-style-type: none"> <li>To develop programs to solve basic problems by understanding basic concepts in C language</li> </ul> |                        |          |
| <b>Course Outcomes</b><br>The student will be able to                              |                                                                 |                                                                                                                                             | <b>Cognitive Level</b> |          |
| <b>CO1</b>                                                                         | Formulate the algorithms for simple problems                    |                                                                                                                                             | Ap                     |          |
| <b>CO2</b>                                                                         | Apply the concept of pointers of different types                |                                                                                                                                             | Ap                     |          |
| <b>CO3</b>                                                                         | Apply and manipulate data with arrays, strings and structures   |                                                                                                                                             | Ap                     |          |
| <b>CO4</b>                                                                         | Apply the concept of functions and dynamic memory allocation    |                                                                                                                                             | Ap                     |          |
| <b>CO5</b>                                                                         | Analyse and correct logical errors encountered during execution |                                                                                                                                             | An                     |          |

### C-Programming:

- Draw the flowchart for the following using Raptor tool.
  - Simple interest calculation
  - Greatest among three numbers
  - Find the sum of digits of a number
- Programs for demonstrating the use of different types of operators like arithmetic, logical, relational and ternary operators (Sequential and Selection structures)
- Programs for demonstrating repetitive control statements like 'for', 'while' and 'do-while' (Iterative structures)
- Programs for demonstrating one-dimensional and two-dimensional numeric array
- Programs to demonstrate modular programming concepts using functions
- Programs to implement various character and string operations with and without built-in library functions.
- Programs to demonstrate the use of pointers
- Programs to illustrate the use of user-defined data types
- Programs to implement various file management.
- Program Using Dynamic memory allocation functions

**HARDWARE / SOFTWARE REQUIRED FOR A BATCH OF 30 STUDENTS:****Hardware:**

- LAN System with 33 nodes (OR) Standalone PCs – 33 Nos.
- Printers – 3 Nos.

**Software:**

- RAPTOR Tool
- Compiler – C

**TOTAL (P:60) : 60 PERIODS**

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   | 2 | 2 |   |   |   |   |   |   |    | 3  | 3    | 3 |
| 2                              | 3   | 2 | 3 |   |   |   |   |   |   |    | 3  | 3    | 3 |
| 3                              | 3   | 2 | 3 |   |   |   |   |   |   | 3  | 3  | 3    | 3 |
| 4                              | 3   | 2 | 3 |   |   |   |   | 3 |   | 3  | 3  | 3    | 3 |
| 5                              | 3   | 2 | 3 |   |   |   |   |   |   | 3  | 3  | 3    | 3 |
| CO<br>(W.A)                    | 3   | 2 | 2 |   |   |   |   | 3 |   | 3  | 3  | 3    | 3 |

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| 22PYP01 - PHYSICS LABORATORY |                                                                                                                                                                                                                                                                             |   |                 |   |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------|---|
| (Common to All Branches)     |                                                                                                                                                                                                                                                                             |   |                 |   |
|                              | L                                                                                                                                                                                                                                                                           | T | P               | C |
|                              | 0                                                                                                                                                                                                                                                                           | 0 | 2               | 1 |
| PRE REQUISITE : NIL          |                                                                                                                                                                                                                                                                             |   |                 |   |
| Course Objective:            | <ul style="list-style-type: none"><li>To infer the practical knowledge by applying the experimental methods to correlate with the Physics theory.</li><li>To introduce different experiments to test basics of physics concepts applied in optics and electronics</li></ul> |   |                 |   |
| Course Outcomes              |                                                                                                                                                                                                                                                                             |   | Cognitive Level |   |
| The Student will be able to  |                                                                                                                                                                                                                                                                             |   |                 |   |
| CO1                          | Examine the effects of material type and loading conditions on the results of the non-uniform bending experiment.                                                                                                                                                           |   | An              |   |
| CO2                          | Utilize principles of light interaction to determine the particle size of materials using laser diffraction techniques.                                                                                                                                                     |   | Ap              |   |
| CO3                          | Evaluate the accuracy of the wavelength of different colors with the accepted values in the literature                                                                                                                                                                      |   | E               |   |
| CO4                          | Measure the effectiveness of the solar cell based on its V-I characteristics.                                                                                                                                                                                               |   | E               |   |
| CO5                          | Analyze the principles underlying the Air wedge method for the determination of the thickness of a thin wire,                                                                                                                                                               |   | An              |   |

| <b>PHYSICS LABORATORY (Any Five)</b> |                                                                               |
|--------------------------------------|-------------------------------------------------------------------------------|
| 1.                                   | Determination of Young's modulus by non-uniform bending method                |
| 2.                                   | Determination of (a) wavelength and (b) particle size using Laser.            |
| 3.                                   | Determination of thermal conductivity of a bad conductor – Lee's Disc method. |
| 4.                                   | Determination of wavelength of mercury spectrum – spectrometer grating        |
| 5.                                   | Determination of band gap of a semiconductor.                                 |
| 6.                                   | Determination of thickness of a thin wire – Air wedge method.                 |
| 7.                                   | Determination of V-I characteristics of solar cell.                           |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 2                              | 3   |   |   |   |   |   |   |   |   |    | 2  |      |   |
| 3                              | 3   | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 4                              | 3   |   |   |   |   |   |   |   |   |    | 2  |      |   |
| 5                              | 3   | 3 |   |   |   |   |   |   |   |    |    | 1    | 1 |
| CO<br>(w.a)                    | 3   | 3 |   |   |   |   |   |   |   |    | 2  | 1    | 1 |

M. Yf

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| 22MAN02R - SOFT/ANALYTICAL SKILLS – I<br>(Common to All Branches) |                                                                                      |                                                                                                                                                                                                                                       |                 |                                                |   |   |
|-------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------------------------------------------|---|---|
|                                                                   |                                                                                      |                                                                                                                                                                                                                                       | L               | T                                              | P | C |
|                                                                   |                                                                                      |                                                                                                                                                                                                                                       | I               | 0                                              | 2 | 0 |
| PREREQUISITE : Nil                                                |                                                                                      |                                                                                                                                                                                                                                       |                 |                                                |   |   |
| Course Objective:                                                 |                                                                                      | <ul style="list-style-type: none"><li>• To analyze wide range of texts, understand and express interpretations</li><li>• To learn various methods for faster numerical computations and to develop logical reasoning skills</li></ul> |                 |                                                |   |   |
| Course Outcomes<br>The Student will be able to                    |                                                                                      |                                                                                                                                                                                                                                       | Cognitive Level | Weightage of COs in Continuous Assessment Test |   |   |
| CO1                                                               | Respond to diverse texts, enhancing their comprehensive and expressive capabilities. |                                                                                                                                                                                                                                       | U               | 40%                                            |   |   |
| CO2                                                               | Apply various techniques for quicker calculations.                                   |                                                                                                                                                                                                                                       | Ap              | 30%                                            |   |   |
| CO3                                                               | Solve mathematical problems by applying logical thinking.                            |                                                                                                                                                                                                                                       | An              | 30%                                            |   |   |

|                                                                                                                                                                                                                                  |               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| <b>UNIT I – VERBAL ABILITY</b>                                                                                                                                                                                                   | <b>(5+10)</b> |
| <b>Grammar-</b> Synonyms - Antonyms - Articles - Preposition - <b>Listening</b> - IELTS Listening (Beginners) - <b>Speaking</b> - Presentation - JAM - <b>Reading</b> - Reading Comprehension - <b>Writing</b> - E-mail writing. |               |
| <b>UNIT II – APTITUDE</b>                                                                                                                                                                                                        | <b>(5+10)</b> |
| Square Root - Squaring of Numbers - Cube root -Cube of Numbers - Number Systems - L.C.M & H.C.F - Simplification - Problems on Numbers - Calendars - Clocks.                                                                     |               |
| <b>UNIT III - REASONING</b>                                                                                                                                                                                                      | <b>(5+10)</b> |
| Odd Man Out & Number Series - Letter Series - Coding and Decoding - Analogy - Mirror and Water Images.                                                                                                                           |               |
| <b>TOTAL(L:45) = 45 PERIODS</b>                                                                                                                                                                                                  |               |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <ol style="list-style-type: none"> <li>I. Rizvi, M.Ashraf. Effective Technical Communication. Tata McGraw-Hill Education, 2017.</li> <li>Aggarwal R S. Quantitative Aptitude for Competitive Examinations. S.Chand Publishing Company Ltd(s)., 2022.</li> <li>Sharma, Arun. How to Prepare for Quantitative Aptitude for the CAT. Tata McGraw – Hill Publishing, 2022.</li> <li>Praveen R V. Quantitative Aptitude and Reasoning. PHI Learning Pvt. Ltd., 2016.</li> </ol> |

| Mapping of COs with POs /<br>PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|-----------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                               | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                   | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                                 |     |   |   |   |   |   |   | 2 | 3 |    |    |      |   |
| 2                                 |     | 2 |   | 2 |   |   |   |   |   |    |    |      |   |
| 3                                 |     | 2 |   | 2 |   |   |   |   |   |    |    |      |   |
| CO<br>(W.A)                       |     | 1 |   | 1 |   |   |   | 1 | 1 |    |    |      |   |

M. 48

| 22MAN05 - YOGA – II<br>(For Common To All Branches)                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                           |                        |                                                     |          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                                                                                                                                                                                                                                                                                                      | <b>L</b>                                                                                                                                                                                                                                                                                                                                                                                  | <b>T</b>               | <b>P</b>                                            | <b>C</b> |
|                                                                                                                                                                                                                                                                                                                                      | <b>0</b>                                                                                                                                                                                                                                                                                                                                                                                  | <b>0</b>               | <b>1</b>                                            | <b>0</b> |
| <b>PRE - REQUISITE : NIL</b>                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                           |                        |                                                     |          |
| <b>Course Objective:</b>                                                                                                                                                                                                                                                                                                             | <ul style="list-style-type: none"> <li>To strengthen the body through physical exercises.</li> <li>To understand the importance of value system and ethics.</li> <li>To know the life philosophy of yogis and maharishis.</li> <li>To understand the nature laws, cause and effect theory.</li> <li>To inculcate knowledge about different types of Asanas and their benefits.</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                           | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                                                                                                                                                                                                                                                                                                  | Perform physical exercises like spine exercises, massage and acupressure.                                                                                                                                                                                                                                                                                                                 | Ap                     | Internal Assessment                                 |          |
| CO2                                                                                                                                                                                                                                                                                                                                  | Learn the human values, ethics, time management and the importance of introspection.                                                                                                                                                                                                                                                                                                      | U                      |                                                     |          |
| CO3                                                                                                                                                                                                                                                                                                                                  | Analyze various life philosophies of yogi's and rishi's.                                                                                                                                                                                                                                                                                                                                  | An                     |                                                     |          |
| CO4                                                                                                                                                                                                                                                                                                                                  | Understand life lessons and nature laws.                                                                                                                                                                                                                                                                                                                                                  | U                      |                                                     |          |
| CO5                                                                                                                                                                                                                                                                                                                                  | Demonstrate different types of yoga Asanas and improve their personal fitness.                                                                                                                                                                                                                                                                                                            | Ap                     |                                                     |          |
| <b>UNIT I – PHYSICAL EXERCISES (PART-II)</b>                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                           |                        |                                                     | (3)      |
| Breathing Exercises – Kapalapathi – Maharasanam (Spine Exercises) – Massage and Acupressure.                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                           |                        |                                                     |          |
| <b>UNIT II – HUMAN VALUE</b>                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                           |                        |                                                     | (3)      |
| Divine power – Life force (Bio magnetism) – Importance of Introspection – Time management – Punctuality – self confidence – mind control.                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                           |                        |                                                     |          |
| <b>UNIT III – PHILOSOPHY OF LIFE</b>                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                           |                        |                                                     | (3)      |
| Basic needs for life – Hunger and thirst – climatic/weather changes – Body wastes – pressure of excretory organs – safety measures – protection from natural disaster – protection from enmity – protection from accidents – ethics – morality – duty – charity – Wisdom of perfection stages – faith – understanding – realization. |                                                                                                                                                                                                                                                                                                                                                                                           |                        |                                                     |          |
| <b>UNIT IV – NATURE'S LAW OF CAUSE AND EFFECT</b>                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                           |                        |                                                     | (3)      |
| Food transformation into seven minerals – Natural actions – pattern – precision – regularity – Required skills – planned work – awareness – introspection.                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                           |                        |                                                     |          |
| <b>UNIT V – ASANAS (PART-II)</b>                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                           |                        |                                                     | (3)      |
| Ustrasana – Vakrasana – Komugasana – Padmasana – Vajrasana – Sukhasana – Yogamudra – mahamudra.                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                           |                        |                                                     |          |
| <b>TOTAL (P:15) : 15 PERIODS</b>                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                           |                        |                                                     |          |

**TEXT BOOKS/REFERENCES:**

1. Light On Yoga by B.K.S. Iyengar.

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              |     |   |   |   |   |   | 3 | 2 |   |    | 3  |      |   |
| 2                              |     |   |   |   |   |   | 3 | 2 |   |    | 3  |      |   |
| 3                              |     |   |   |   |   |   | 3 | 2 |   |    | 3  |      |   |
| 4                              |     |   |   |   |   |   | 3 | 2 |   |    | 3  |      |   |
| 5                              |     |   |   |   |   |   | 3 | 2 |   |    | 3  |      |   |
| CO<br>(W.A)                    |     |   |   |   |   |   | 3 | 2 |   |    | 3  |      |   |



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| <b>22MYB03 - STATISTICS AND NUMERICAL METHODS</b><br><b>(Common to AGRI, AI&amp;DS,CSE,IT,IOT,CS(Cyber security)CIVIL,CHEMICAL,EEE,MECH Branches)</b> |                                                                                                                                                                                                                                                                                                                                                                              |                        |                                                     |          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                                                                                                                       | <b>L</b>                                                                                                                                                                                                                                                                                                                                                                     | <b>T</b>               | <b>P</b>                                            | <b>C</b> |
|                                                                                                                                                       | <b>3</b>                                                                                                                                                                                                                                                                                                                                                                     | <b>1</b>               | <b>0</b>                                            | <b>4</b> |
| <b>PREREQUISITE : NIL</b>                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                              |                        |                                                     |          |
| <b>Course Objective:</b>                                                                                                                              | <ul style="list-style-type: none"> <li>• To understand the concept of testing of hypothesis for small and large samples and design of experiments.</li> <li>• To provide adequate knowledge in numerical techniques to solving ordinary differential equations and numerical integration which plays an important role in engineering and technology disciplines.</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                              | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| <b>CO1</b>                                                                                                                                            | Interpret the principles and techniques in experimental design to solve the variance                                                                                                                                                                                                                                                                                         | Ap                     | 20%                                                 |          |
| <b>CO2</b>                                                                                                                                            | Apply the fundamental numerical techniques used to solve various types of mathematical problems on solution of equations, interpolation and numerical integration.                                                                                                                                                                                                           | Ap                     | 40%                                                 |          |
| <b>CO3</b>                                                                                                                                            | Determine the statistics based on the data and related to the testing of hypothesis.                                                                                                                                                                                                                                                                                         | An                     | 20%                                                 |          |
| <b>CO4</b>                                                                                                                                            | Solve the real-world problems using numerical methods for IVPs, demonstrating their applicability and limitations.                                                                                                                                                                                                                                                           | Ap                     | 20%                                                 |          |
| <b>CO5</b>                                                                                                                                            | Demonstrate the importance of interpolation and approximation techniques to solve real-world problems in various disciplines of Engineering using modern tools.                                                                                                                                                                                                              | Ap                     | Internal Assessment                                 |          |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>UNIT I - TESTING OF HYPOTHESIS</b>                                                                                                                                                                                                                                              | <b>(9+3)</b> |
| Sampling Distributions-Tests for single mean, difference of means (Large and Small samples)<br>Using z, t -distribution, F – distribution- Chi-square - Test for independence of attributes and Goodness of fit.                                                                   |              |
| <b>UNIT II - DESIGN OF EXPERIMENTS</b>                                                                                                                                                                                                                                             | <b>(9+3)</b> |
| Analysis of variance- Completely randomized design - Randomized block design - Latin square design.                                                                                                                                                                                |              |
| <b>UNIT III - SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS</b>                                                                                                                                                                                                                   | <b>(9+3)</b> |
| Solution of algebraic and transcendental equations - Fixed point iteration method - Newton Raphson method- Solution of linear system of equations Gauss elimination method – Iterative methods of Gauss Jacobi and Gauss Seidel Methods- Eigen values of a matrix by Power method. |              |
| <b>UNIT IV - INTERPOLATION AND APPROXIMATION</b>                                                                                                                                                                                                                                   | <b>(9+3)</b> |
| Lagrange's and Newton's divided difference interpolations - Newton's forward and backward difference interpolation - Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules - Romberg's Methods.                                                       |              |

|                                                                                                                                                                                                                                                                                                            |              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>UNITY - NUMERICAL DIFFERENTIATION AND INTEGRATION</b>                                                                                                                                                                                                                                                   | <b>(9+3)</b> |
| Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge - Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations. |              |
| <b>TOTAL (L:45+T:15) : 60 PERIODS</b>                                                                                                                                                                                                                                                                      |              |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOK:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <ol style="list-style-type: none"> <li>1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.</li> <li>2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8<sup>th</sup> Edition, 2015.</li> <li>3. Gupta S.C. and Kapoor V. K., "Fundamentals of Mathematical Statistics", Sultan Chand &amp; Sons, New Delhi, 12<sup>th</sup> Edition, 2020.</li> </ol> |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <ol style="list-style-type: none"> <li>1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9<sup>th</sup> Edition, Cengage Learning, 2016.</li> <li>2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8<sup>th</sup> Edition, 2014.</li> <li>3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7<sup>th</sup> Edition, 2007.</li> </ol>                                                                   |
| <b>WEB REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <ol style="list-style-type: none"> <li>1. <a href="https://youtu.be/zmyh7nCjmsg">https://youtu.be/zmyh7nCjmsg</a></li> <li>2. <a href="https://youtu.be/NmgbFJ4UwPs">https://youtu.be/NmgbFJ4UwPs</a></li> <li>3. <a href="https://youtu.be/RgKy7URFxIc">https://youtu.be/RgKy7URFxIc</a></li> <li>4. <a href="https://archive.nptel.ac.in/courses/111/107/111107105/">https://archive.nptel.ac.in/courses/111/107/111107105/</a></li> </ol>                                                                             |

| Mapping of COs with POs / PSOs |          |          |   |   |          |   |   |          |   |    |          |          |   |
|--------------------------------|----------|----------|---|---|----------|---|---|----------|---|----|----------|----------|---|
| COs                            | POs      |          |   |   |          |   |   |          |   |    |          | PSOs     |   |
|                                | 1        | 2        | 3 | 4 | 5        | 6 | 7 | 8        | 9 | 10 | 11       | 1        | 2 |
| 1                              | 3        |          |   |   |          |   |   |          |   |    |          |          |   |
| 2                              | 3        |          |   |   |          |   |   |          |   |    |          |          |   |
| 3                              |          | 2        |   |   |          |   |   |          |   |    |          |          |   |
| 4                              | 3        |          |   |   |          |   |   |          |   |    |          | 2        |   |
| 5                              | 3        |          |   |   | 2        |   |   | 3        |   |    | 2        | 2        |   |
| <b>CO (W.A)</b>                | <b>3</b> | <b>2</b> |   |   | <b>2</b> |   |   | <b>3</b> |   |    | <b>2</b> | <b>2</b> |   |

*Signature*

| 22MEC04 - ENGINEERING THERMODYNAMICS<br>(Use of Steam Tables and Psychrometric Chart permitted) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                        |                                                     |          |
|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>L</b>               | <b>T</b>                                            | <b>P</b> |
|                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>2</b>               | <b>I</b>                                            | <b>0</b> |
| <b>PREREQUISITE : NIL</b>                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                        |                                                     |          |
| <b>Course Objective:</b>                                                                        | <ul style="list-style-type: none"> <li>To teach the basic concept of thermodynamics and applications of first law of thermodynamics</li> <li>To introduce the concept of second law of thermodynamics and entropy</li> <li>To teach steps involved in analysis of gas power cycles</li> <li>To provide knowledge on the process of steam formation at various conditions</li> <li>To impart the knowledge in Psychrometry and Psychrometric processes</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                                                             | Apply the fundamental laws of thermodynamics to analyze energy interactions, entropy changes, and the performance of various thermodynamic systems and processes.                                                                                                                                                                                                                                                                                                | Ap                     | 40%                                                 |          |
| CO2                                                                                             | Apply air standard cycles to analyze efficiency, work ratio, and performance parameters of various gas power cycles.                                                                                                                                                                                                                                                                                                                                             | Ap                     | 20%                                                 |          |
| CO3                                                                                             | Apply thermodynamic relations and steam property concepts to analyze phase changes, energy interactions, and behavior of pure substances.                                                                                                                                                                                                                                                                                                                        | Ap                     | 20%                                                 |          |
| CO4                                                                                             | Analyze psychrometric properties and processes using charts and relations to evaluate moist air behavior in various engineering applications.                                                                                                                                                                                                                                                                                                                    | An                     | 20%                                                 |          |
| CO5                                                                                             | Seminar presentation on real-time applications of engineering thermodynamics.                                                                                                                                                                                                                                                                                                                                                                                    | U                      | Internal Assessment                                 |          |

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| <b>UNIT I - BASIC CONCEPT, ZEROth AND FIRST LAW OF THERMODYNAMICS</b>                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>(6+3)</b> |
| Definitions - Thermodynamic systems - thermodynamic equilibrium - properties, state, process and cycle - point and path function - Zeroth law - reversible and Irreversible processes - energy, work and heat - internal energy - First Law - energy as a property of a system - PMM I - application of first law to closed system and steady Flow processes - applications of steady flow energy equation - steam turbine, centrifugal compressor, nozzle - limitations of first law. |              |
| <b>UNIT II - SECOND LAW OF THERMODYNAMICS AND ENTROPY</b>                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>(6+3)</b> |
| Second Law - performance of heat engines and reversed heat engines - reversible processes - statements of Second Law - PMM 2 - Clausius inequality - Carnot cycle - Carnot's theorem and corollary - entropy as a property of a system - entropy and irreversibility - entropy changes for a closed system and open system - Third Law of Thermodynamics.                                                                                                                              |              |
| <b>UNIT III - GAS POWER CYCLES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>(6+3)</b> |
| Air standard efficiency - Otto cycle - Diesel cycle - dual combustion cycle - Brayton cycle - work ratio - pressure ratio for maximum work - calculation of air standard efficiency.                                                                                                                                                                                                                                                                                                   |              |

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| <b>UNIT IV - PROPERTIES OF PURE SUBSTANCES AND THERMODYNAMIC RELATIONS</b>                                                                                                                                                                                                                                                                                                                                                                                                        | <b>(6+3)</b> |
| Pure substances - definition - phase change - p-T diagram - P-V-T surface - phase change terminologies - formation of steam - thermodynamic properties of steam - external work done during evaporation - internal latent heat - internal energy of steam - Entropy of water, evaporation, wet steam, superheated steam - Mollier diagram – Thermodynamic relations – Maxwell equations – TDS equations- heat capacities relations – energy equation – joule Thomson coefficient. |              |
| <b>UNIT V - PSYCHROMETRY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>(6+3)</b> |
| Concept of psychrometry and psychrometrics - psychrometric Relations - pressure, specific humidity, degree of saturation, relative humidity, enthalpy of moist air - Sling psychrometer - psychrometric charts - Psychrometric processes                                                                                                                                                                                                                                          |              |
| <b>TOTAL (L:30 +T:15) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                            |              |

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
| 1. Rajput. R. K, “A Textbook of Engineering Thermodynamics”, 5th ed., Laxmi Publications, 2017<br>2. Michael A. Boles, Yunus A. Cengel, “Thermodynamics: An Engineering Approach”, 9 <sup>th</sup> ed., Tata McGraw-Hill Education, 2019                                                                                                                                                                                                                                          |  |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
| 1. Nag. P. K, “Engineering Thermodynamics”, 5th ed., McGraw Hill Education, 2013<br>2. Arora. C. P, Thermodynamics, Tata McGraw-Hill Education, 2003<br>3. Moran, Shapiro, Boettner and Bailey “Principles of Engineering Thermodynamics”, 8 <sup>th</sup> ed., Wiley India Pvt. Ltd, 2015<br>4. Holman. J. P, “Thermodynamics”, 10 <sup>th</sup> ed., McGraw Hill Education, 2011<br>5. Rao. Y. V. C, “An Introduction to Thermodynamics”, Revised Edition, Orient Longman, 2009 |  |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | I   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | I    | 2 |
| 1                              | 3   | 3 |   |   |   |   |   |   |   |    |    | 2    |   |
| 2                              | 3   | 3 |   |   |   |   |   |   |   |    |    | 2    |   |
| 3                              | 3   | 3 |   |   |   |   |   |   |   |    |    | 2    |   |
| 4                              |     | 3 | 2 |   |   |   |   |   |   |    |    | 2    |   |
| 5                              |     |   |   |   |   |   |   |   | 2 |    |    |      |   |
| CO (W.A)                       | 3   | 3 | 2 |   |   |   |   |   | 2 |    |    | 2    |   |

| 22MEC05 - FLUID MECHANICS AND MACHINERY        |                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |   |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                                                                            | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | T                                            | P | C |
|                                                |                                                                                                                                                                                            | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0                                            | 2 | 4 |
| PREREQUISITE : NIL                             |                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |   |
| Course Objective:                              |                                                                                                                                                                                            | <ul style="list-style-type: none"><li>• To introduce the fundamentals of fluid mechanics and its properties</li><li>• To impart basic knowledge to determine major and minor losses in flow through pipes and boundary layer concept.</li><li>• To give the fundamental knowledge on physical quantities and to predict the behavior of the prototype/model by applying model laws.</li><li>• To introduce the types and working principles of hydraulic turbines and evaluate the performance of hydraulic turbines</li><li>• To understand the functioning and characteristic curves of pumps</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                            | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Analyse fluid flow behaviour within control volumes by applying the concepts of fluid properties and principle of continuity equation.                                                     | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20 %                                         |   |   |
| CO2                                            | Calculate energy losses and pressure variations of flowing fluid in pipe systems                                                                                                           | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20 %                                         |   |   |
| CO3                                            | Analyse the nature of physical quantities and behaviour of the prototype/model by applying model laws.                                                                                     | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20 %                                         |   |   |
| CO4                                            | Calculate the performance of hydraulic turbines and Pumps                                                                                                                                  | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 40 %                                         |   |   |
| CO5                                            | Demonstrate the fundamental concepts of fluid mechanics and explain the performance of turbines and pumps while working in a team and communicate the same through effective presentations | U                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Internal Assessment                          |   |   |

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| <b>UNIT I - FLUID PROPERTIES AND FLOW CHARACTERISTICS</b>                                                                                                                                                                                                                                                                                         | <b>(9)+(3)</b> |
| Units and dimensions – Definition of fluids - Properties of fluids - mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, surface tension and capillarity. Flow characteristics -concept of control volume - application of continuity equation, energy equation and momentum equation. |                |
| <b>UNIT II - FLOW THROUGH CIRCULAR CONDUITS</b>                                                                                                                                                                                                                                                                                                   | <b>(9)+(3)</b> |
| Laminar flow through circular conduits – Hagen Poiseuille equation - Boundary layer concepts -types of boundary layer thickness -Darcy Weisbach equation –friction factor - Moody diagram - minor losses - Flow through pipes in series and parallel - Hydraulic and energy gradient lines.                                                       |                |
| <b>UNIT III - DIMENSIONAL ANALYSIS AND SIMILITUDE</b>                                                                                                                                                                                                                                                                                             | <b>(9)</b>     |
| Fundamental dimensions - Dimensional homogeneity – dimensional analysis by using Buckingham's $\pi$ theorem method - Similitude – types of similitude - Dimensionless parameters - application of dimensionless Parameters-Model analysis.                                                                                                        |                |

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| <b>UNIT IV - TURBINES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>(9)+(5)</b> |
| Classification of turbines -heads and efficiencies -velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines - working principles - work done by water on the runner - unit quantities - Specific speed.                                                                                                                                                                                                                                                                                                                                                    |                |
| <b>UNIT V - PUMPS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>(9)+(4)</b> |
| Classification of Pumps - Centrifugal pumps-working principle - work done by the impeller - various efficiencies-velocity components at entry and exit of the rotor - velocity triangles - Reciprocating pump - working principle - work done.                                                                                                                                                                                                                                                                                                                                                                  |                |
| <b>List of Experiments</b> <ol style="list-style-type: none"> <li>1. Verification of Bernoulli's equation</li> <li>2. Determination of the coefficient of discharge of given Orifice meter/ Venturimeter.</li> <li>3. Determination of friction factor for a given set of pipes</li> <li>4. Determination of minor losses in pipes</li> <li>5. Performance studies on Pelton wheel</li> <li>6. Performance studies on Francis turbine</li> <li>7. Performance studies on of Kaplan turbine</li> <li>8. Performance studies on centrifugal pump</li> <li>9. Performance studies on reciprocating pump</li> </ol> |                |
| <b>TOTAL (L:45 + P:15) = 60 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                |

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| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 2. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi. 2019. Revised 9 <sup>th</sup> Edition (Unit I, II, III, IV, V)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <ol style="list-style-type: none"> <li>1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House, New Delhi 2019. 22nd Edition (Unit I, II, III, IV, V)</li> <li>2. Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, "Fluid Mechanics and Machinery", John Wiley &amp; Sons; 9th Edition SI Version 2015. (UNIT - I, II, III, IV, V)</li> <li>3. Kumar. K.L., Engineering Fluid Mechanics, S Chand., New Delhi, 2016. 8th Edition (Unit I, II, III)</li> <li>4. Streeter. V. L., and Wylie, E.B., Fluid Mechanics, McGraw Hill, 2017. 9th Edition (Unit I, II, III)</li> <li>5. Rajput. R. K., "A text book of Fluid Mechanics and Hydraulic Machines", S. Chand &amp; Company Ltd., New Delhi, sixth edition, 2010 (Unit I, II, III, IV, V).</li> </ol> |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | I   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | I    | 2 |
| 1                              | 3   | 3 |   |   |   |   |   | 3 |   |    |    | 3    |   |
| 2                              | 3   |   |   |   |   |   |   | 3 |   |    |    | 3    |   |
| 3                              | 3   | 3 |   |   |   |   |   | 3 |   |    |    | 3    |   |
| 4                              | 3   |   |   |   |   |   |   | 3 |   |    |    | 3    |   |
| 5                              |     |   |   |   |   |   |   | 3 | 3 |    |    | 3    |   |
| CO (W.A)                       | 3   | 3 |   |   |   |   |   | 3 | 3 |    |    | 3    |   |

| 22MEC06 – MANUFACTURING PROCESSES              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                                              |   |   |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | L               | T                                            | P | C |
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                                              |   |   |
| Course Objective:                              | <ul style="list-style-type: none"><li>• To acquire knowledge on basic concepts of foundry and casting processes</li><li>• To learn various metal joining processes and gain welding skills.</li><li>• To provide the knowledge on various bulk deformation processes and its applications.</li><li>• To expose knowledge on sheet metal forming processes and special forming processes and to make small sheet metal parts.</li><li>• To learn about the various plastics moulding and forming processes and to make simple plastic part.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply the metal casting components and joining process                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Ap              | 20%                                          |   |   |
| CO2                                            | Analyze the metal joining processes in different methods.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | An              | 20%                                          |   |   |
| CO3                                            | Identify the various kinds of deformation process in manufacturing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Ap              | 40%                                          |   |   |
| CO4                                            | Evaluate the forming process under various operations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | An              | 20%                                          |   |   |
| CO5                                            | Develop a project based learning by identifying the suitable materials and manufacturing processes as a member/ team.                                                                                                                                                                                                                                                                                                                                                                                                                                | Cr              | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |     |
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| <b>UNIT I - METAL CASTING PROCESSES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                   | (9) |
| Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Molding sand Properties and testing – Cores –Types and applications – Molding machines – Types and applications– Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould – Pressure die casting – low pressure, gravity- Tilt pouring, high pressure die casting- Centrifugal Casting – CO2 casting – - Defects in Sand casting process-remedies.            |     |
| <b>UNIT II - METAL JOINING PROCESSES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                  | (9) |
| Fusion welding processes – Oxy fuel welding – Filler and Flux materials–Arc welding, Electrodes, Coating and specifications – Gas Tungsten arc welding –Gas metal arc welding - Submerged arc welding – Electro slag welding– Plasma arc welding — Resistance welding Processes -Electron beam welding –Laser beam Welding Friction welding – Friction stir welding – Diffusion welding – Thermit Welding, Weld defects – Inspection & remedies – Brazing - soldering – Adhesive bonding. |     |
| <b>UNIT III - BULK DEFORMATION PROCESSES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                              | (9) |
| Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – cold forging- Characteristics of the processes – Typical forging operations – rolling of metals – Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts – Principle of rod and wire Drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion. Introduction to shaping operations.                                    |     |
| <b>UNIT IV - SHEET METAL FORMING AND SPECIAL FORMING PROCESSES</b>                                                                                                                                                                                                                                                                                                                                                                                                                        | (9) |
| Sheet metal characteristics – Typical shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes - Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning – Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming – Incremental forming.                                                                     |     |

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| <b>UNIT V - MANUFACTURE OF PLASTIC COMPONENTS</b>                                                                                                                                                                                                                                                                                                                                                             | <b>(9)</b> |
| Types and characteristics of plastics – Molding of thermoplastics & Thermosetting polymers– working principles and typical applications – injection molding – Plunger and screw machines – Compression molding, Transfer Molding – Typical industrial applications – introduction to blow molding – Rotational molding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics- duff moulding. |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                              |            |

| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 1. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India, 4th Edition, 2013<br>2. P.N .Rao Manufacturing Technology Volume I McGrawhill Education 5th edition, 2018.                                                                                                                                                                                                                                                                                                                                                                        |  |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| 1. HajraChoudhury S.K, HajraChoundhury A.K and Nirjhar Roy, “Elements of Workshop Technology”, Vol. I, 2017<br>2. HMT, “Production Technology”, “McGraw Hill Education”, 2017<br>3. Sharma.P.C, “A Textbook of Production Technology”, S. Chand Publications, 2014<br>4. S. Gowri P. Hariharan, A.SureshBabu, Manufacturing Technology I, Pearson Education, 2008.<br>5. Ro y. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.<br>6. Rajput.R.K, “A Textbook of Manufacturing Technology”, 2nd ed., Laxmi Publications (P) Ltd, 2016 |  |

|          | I | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | I | 2 |
|----------|---|---|---|---|---|---|---|---|---|----|----|---|---|
| I        | 3 |   |   |   |   |   |   |   |   |    |    | 3 |   |
| 2        |   |   | 2 |   |   | 3 |   |   |   |    |    |   |   |
| 3        |   |   |   |   |   |   |   |   | 2 |    |    |   |   |
| 4        |   | 3 |   |   |   |   |   |   |   |    |    |   |   |
| 5        |   |   |   |   |   |   |   |   |   |    | 3  |   |   |
| CO (W.A) | 3 | 3 | 2 |   |   | 3 |   |   | 2 |    | 3  | 3 |   |



| 22MEC07 - ENGINEERING MATERIALS AND METALLURGY |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                                              |   |   |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | L               | T                                            | P | C |
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |                                              |   |   |
| Course Objective:                              | <ul style="list-style-type: none"><li>To develop the knowledge on structure of materials including crystallography, microstructure, defect</li><li>To understand the importance of various ferrous materials and phase diagram.</li><li>To apply the suitable heat treatment process to enhance the property of a material.</li><li>To know mechanical properties of materials.</li><li>To give insight into advanced materials such as polymers, ceramics and composite and their applications.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply knowledge of crystal structures and crystal defects to determine their influence on material behavior and mechanical properties.                                                                                                                                                                                                                                                                                                                                                                     | Ap              | 20%                                          |   |   |
| CO2                                            | Interpret binary phase diagrams and transformation curves (TTT/CCT) to predict phase evolution in metallic alloys.                                                                                                                                                                                                                                                                                                                                                                                         | Ap              | 20%                                          |   |   |
| CO3                                            | Select appropriate heat treatment methods for improving mechanical properties of ferrous alloys based on desired applications.                                                                                                                                                                                                                                                                                                                                                                             | Ap              | 20%                                          |   |   |
| CO4                                            | Analyze mechanical test data to evaluate material behavior under tensile, impact, creep, and torsion conditions and recommend suitable materials for engineering applications.                                                                                                                                                                                                                                                                                                                             | An              | 40%                                          |   |   |
| CO5                                            | Demonstrate an understanding of the fundamental properties of engineering materials and communicate them effectively through structured presentations                                                                                                                                                                                                                                                                                                                                                      | Ap              | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                               |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - STRUCTURES OF MATERIALS</b>                                                                                                                                                                                                                                                                                                                                                                                       | <b>(9)</b> |
| Materials Science - Simple Crystal Structures - BCC, FCC, HCP Structures - Unit Cell - Defects - Point, Line, Surface, Volume - Slip planes and slip systems - Schmid's rule - Polymorphism and allotropy.                                                                                                                                                                                                                    |            |
| <b>UNIT II - PHASE DIAGRAMS AND PHASE TRANSFORMATION</b>                                                                                                                                                                                                                                                                                                                                                                      | <b>(9)</b> |
| Gibbs's Phase rule - Solidification and Solid Solutions - Equilibrium Diagrams - Classification of Equilibrium Diagrams - Isomorphous System - Eutectic systems, Eutectoid, Peritectic and Peritectoid system - Iron-Iron carbide phase diagram - Phase, Time - Temperature - Transformation (TTT), Continuous Cooling Transformation (CCT) and Martensitic Transformation - Types and applications of Steels and Cast Irons. |            |
| <b>UNIT IV - HEAT TREATMENT PROCESS</b>                                                                                                                                                                                                                                                                                                                                                                                       | <b>(9)</b> |
| Heat treatment – Overview – Objectives – Annealing and types, normalizing, quenching, austempering and martempering – microstructure changes – Surface hardening processes - Carburizing – nitriding – cyaniding and carbonitriding, induction and flame hardening, Laser and Electron beam hardening.                                                                                                                        |            |
| <b>UNIT IV - MECHANICAL PROPERTIES OF MATERIALS</b>                                                                                                                                                                                                                                                                                                                                                                           | <b>(9)</b> |
| Testing of Materials - Classification of tests, Tensile test, Impact test, Hardness test Tension and Torsion test - Stress-strain Curve - Fractures in metals - Ductile Fracture, Brittle Fracture - Methods of protection against fracture - Creep test - stages of creep - Prevention of Creep Fracture                                                                                                                     |            |

|                                                                                                                                                                                                                                                                                       |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT V –ADVANCED MATERIALS</b>                                                                                                                                                                                                                                                     | <b>(9)</b> |
| Non Ferrous Metals - Aluminium, Copper, Nickel, Magnesium, Zinc, Lead, Non Ferrous Alloys - Copper alloys, Aluminium alloys - precipitation of hardening, Magnesium alloys and Nickel alloys. Non Metallic Materials - Polymers, Ceramics and Composites - Overview of Nanomaterials. |            |
| <b>TOTAL (L:45) : 45 PERIODS</b>                                                                                                                                                                                                                                                      |            |

|                                                                                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOK:</b>                                                                                                                                                      |
| 1. Balasubramaniam R. “Callister’s Materials Science and Engineering”. 2nd Edition, Wiley India Pvt. Ltd., 2017                                                        |
| <b>REFERENCES:</b>                                                                                                                                                     |
| 1. Kenneth G.Budinski and Michael K.Budinski, Engineering Materials Prentice-Hall of India                                                                             |
| 2. Raghavan.V. Materials Science and Engineering, Prentice Hall of India                                                                                               |
| 3. PremamoyGhosh., “Polymer Science and Technology: Plastics, Rubbers, Blends and Composites”. 3rd Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2011.     |
| 4. SinaEbnesajjad. “Handbook of Biopolymers and Biodegradable Plastics: Properties, Processing and Applications”, 1st Edition, Elsevier, Amsterdam, Netherlands, 2012. |
| 5. Bolton, W., Engineering materials technology: Butterworth-Heinemann.                                                                                                |

| Mapping of COs with POs / PSOs |     |     |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|-----|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |     |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2   | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |     |   |   |   |   |   |   |   |    |    | 2    |   |
| 2                              |     | 3   |   |   |   |   |   |   |   |    |    |      |   |
| 3                              | 2   |     | 3 |   |   |   |   |   |   |    |    |      | 2 |
| 4                              |     |     |   | 2 |   |   |   |   |   |    |    | 2    | 2 |
| 5                              |     | 2   |   |   |   | 2 |   |   |   |    |    | 2    |   |
| <b>CO (W.A)</b>                | 2.5 | 2.5 | 3 | 2 |   | 2 |   |   |   |    |    | 2    | 2 |

| 22MEP02 - COMPUTER AIDED MACHINE DRAWING       |                                                                                                       |                                                                                                                                                                                                                                         |   |   |                 |   |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|-----------------|---|
|                                                |                                                                                                       |                                                                                                                                                                                                                                         | L | T | P               | C |
|                                                |                                                                                                       |                                                                                                                                                                                                                                         | 0 | 0 | 4               | 2 |
| PREREQUISITE : 22MEC02                         |                                                                                                       |                                                                                                                                                                                                                                         |   |   |                 |   |
| Course Objective:                              |                                                                                                       | <ul style="list-style-type: none"><li>• To familiarize the engineering drawing standards and develop proficiency in dimensioning and tolerance techniques.</li><li>• To develop skills in creation of 3D models and assembly.</li></ul> |   |   |                 |   |
| Course Outcomes<br>The Student will be able to |                                                                                                       |                                                                                                                                                                                                                                         |   |   | Cognitive Level |   |
| CO1                                            | Understand the significance of limits and fits in mechanical components assemblies.                   |                                                                                                                                                                                                                                         |   |   | Un              |   |
| CO2                                            | Recognize the principles and symbols of GD&T and their applications in Design.                        |                                                                                                                                                                                                                                         |   |   | Ap              |   |
| CO3                                            | Evaluate the level of accuracy and precision of engineering drawings according to industry standards. |                                                                                                                                                                                                                                         |   |   | E               |   |
| CO4                                            | Generate detailed 3D model of automobile components for manufacturing.                                |                                                                                                                                                                                                                                         |   |   | Ap              |   |
| CO5                                            | Assemble individual 3D models into complete functional units.                                         |                                                                                                                                                                                                                                         |   |   | Ap              |   |

|                                                                                                                                                                                                             |                                                    |           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|-----------|
| <b>PART I</b>                                                                                                                                                                                               | <b>DRAWING STANDARDS &amp; FITS AND TOLERANCES</b> | <b>12</b> |
| Code of practice for Engineering Drawing, Welding symbols, riveted joints, keys, and fasteners Limits, Fits–Tolerancing of individual dimensions - basic principles of Geometric Dimensioning & Tolerancing |                                                    |           |
| <b>PART II</b>                                                                                                                                                                                              | <b>MODELING AND ASSEMBLY</b>                       | <b>48</b> |
| <b>LIST OF EXPERIMENTS :</b>                                                                                                                                                                                |                                                    |           |
| Creation of 3D modeling, assembly and drafting of Plummer Block                                                                                                                                             |                                                    |           |
| Creation of 3D modeling, assembly and drafting of Connecting Rod                                                                                                                                            |                                                    |           |
| Creation of 3D modeling, assembly and drafting of Universal Coupling                                                                                                                                        |                                                    |           |
| Creation of 3D modeling, assembly and drafting of Knuckle Joint                                                                                                                                             |                                                    |           |
| Creation of 3D modeling, assembly and drafting of Screw Jack                                                                                                                                                |                                                    |           |
| <b>TOTAL (P:60) = 60 PERIODS</b>                                                                                                                                                                            |                                                    |           |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | I   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | I    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 2                              | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 3                              |     |   |   |   |   | 3 | 3 |   |   |    |    | 3    | 3 |
| 4                              |     |   | 3 |   |   |   |   |   | 3 |    |    | 3    | 3 |
| 5                              |     |   | 3 |   |   |   |   |   | 3 |    |    |      | 3 |
| CO<br>(W.A)                    | 3   |   | 3 |   |   | 3 | 3 |   | 3 |    |    | 3    | 3 |



| 22MAN04R - SOFT/ANALYTICAL SKILLS – II<br>(Common to All Branches) |                                                                                                                                              |                                                                                                                                                                                       |                                                       |          |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|----------|
|                                                                    |                                                                                                                                              | <b>L</b>                                                                                                                                                                              | <b>T</b>                                              | <b>P</b> |
|                                                                    |                                                                                                                                              | <b>I</b>                                                                                                                                                                              | <b>0</b>                                              | <b>2</b> |
| <b>PREREQUISITE : 22MAN02R</b>                                     |                                                                                                                                              |                                                                                                                                                                                       |                                                       |          |
| <b>Course Objective:</b>                                           |                                                                                                                                              | <ul style="list-style-type: none"> <li>To develop comprehensive English language skills</li> <li>To enhance logical reasoning skills and enhance problem-solving abilities</li> </ul> |                                                       |          |
| <b>Course Outcomes</b><br>The Student will be able to              |                                                                                                                                              | <b>Cognitive Level</b>                                                                                                                                                                | <b>Weightage of COs in Continuous Assessment Test</b> |          |
| CO1                                                                | Comprehend grammar, analyze texts, understand spoken language, articulate ideas in speech, and produce well-structured written compositions. | U                                                                                                                                                                                     | 40%                                                   |          |
| CO2                                                                | Analyze quantitative aptitude problems and find solutions.                                                                                   | Ap                                                                                                                                                                                    | 30%                                                   |          |
| CO3                                                                | Demonstrate the ability to solve problems through logical reasoning.                                                                         | An                                                                                                                                                                                    | 30%                                                   |          |

|                                                                                                                                                                                                                                        |               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| <b>UNIT I – VERBAL ABILITY</b>                                                                                                                                                                                                         | <b>(5+10)</b> |
| <b>Grammar</b> - One Word Substitutions - Phrasal Verbs - <b>Listening</b> - IELTS Listening (Intermediate) - <b>Speaking</b> - Group Discussion - <b>Reading</b> - Reading Newspaper / Articles - <b>Writing</b> - Proverb Expansion. |               |
| <b>UNIT II – APTITUDE</b>                                                                                                                                                                                                              | <b>(5+10)</b> |
| Ratio and Proportion - Allegation and Mixture - Partnership - Average - Problems on Ages - Percentage - Profit and Loss - Height and Distance.                                                                                         |               |
| <b>UNIT III - REASONING</b>                                                                                                                                                                                                            | <b>(5+10)</b> |
| Blood Relationship - Direction Sense - Paper Cutting and Folding - Logical Arrangements and Ranking - Venn Diagram.                                                                                                                    |               |
| <b>TOTAL(L:45) = 45 PERIODS</b>                                                                                                                                                                                                        |               |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <ol style="list-style-type: none"> <li>Rizvi, M.Ashraf. <i>Effective Technical Communication</i>. Tata McGraw-Hill Education, 2017.</li> <li>Aggarwal R S. <i>Quantitative Aptitude for Competitive Examinations</i>. S.Chand Publishing Company Ltd(s)., 2022.</li> <li>Sharma, Arun. <i>How to Prepare for Quantitative Aptitude for the CAT</i>. Tata McGraw – Hill Publishing, 2022.</li> <li>Praveen R V. <i>Quantitative Aptitude and Reasoning</i>. PHI Learning Pvt. Ltd., 2016.</li> </ol> |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              |     |   |   |   |   |   |   | 2 | 3 |    |    |      |   |
| 2                              |     | 2 |   | 2 |   |   |   |   |   |    |    |      |   |
| 3                              |     | 2 |   | 2 |   |   |   |   |   |    |    |      |   |
| CO<br>(W.A)                    |     | 2 |   | 2 |   |   |   | 2 | 3 |    |    |      |   |

M. Y

| 22MAN09 - INDIAN CONSTITUTION<br>(Common to All Branches) |                                                                                                                                                                                                                                                                                                                                                                                                                                             |                        |                                                     |          |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>L</b>               | <b>T</b>                                            | <b>P</b> |
|                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>I</b>               | <b>0</b>                                            | <b>0</b> |
| <b>PREREQUISITE : NIL</b>                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                             |                        |                                                     |          |
| <b>Course Objective:</b>                                  | <ul style="list-style-type: none"> <li>To educate students to learn about the Constitutional Law of India.</li> <li>To motivate students to understand the role of Union Government.</li> <li>To make students to understand about State Government.</li> <li>To understand about District Administration, Municipal Corporation and Zila Panchayat.</li> <li>To encourage students to Understand about the election commission.</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to     |                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| <b>CO1</b>                                                | Gain Knowledge about the Constitutional Law of India.                                                                                                                                                                                                                                                                                                                                                                                       | U                      | Internal Assessment                                 |          |
| <b>CO2</b>                                                | Know the Union Government and role of President and Prime Minister.                                                                                                                                                                                                                                                                                                                                                                         | R                      |                                                     |          |
| <b>CO3</b>                                                | Gain knowledge about State Government and role of Governor, Chief Minister.                                                                                                                                                                                                                                                                                                                                                                 | U                      |                                                     |          |
| <b>CO4</b>                                                | Understand the District Administration, Municipal Corporation and Zila Panchayat.                                                                                                                                                                                                                                                                                                                                                           | U                      |                                                     |          |
| <b>CO5</b>                                                | Understand the role and function of election commission.                                                                                                                                                                                                                                                                                                                                                                                    | U                      |                                                     |          |

|                                                                                                                                                                                                     |            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - The Constitution - Introduction</b>                                                                                                                                                     | <b>(9)</b> |
| The History of the Making of the Indian Constitution - Preamble and the Basic Structure, and its interpretation - Fundamental Rights and Duties and their interpretation - State Policy Principles. |            |
| <b>UNIT II – Union Government</b>                                                                                                                                                                   | <b>(9)</b> |
| Structure of the Indian Union - President – Role and Power - Prime Minister and Council of Ministers - Lok Sabha and Rajya Sabha                                                                    |            |
| <b>UNIT III – State Government</b>                                                                                                                                                                  | <b>(9)</b> |
| Governor – Role and Power - Chief Minister and Council of Ministers - State Secretariat                                                                                                             |            |
| <b>UNIT IV – Local Administration</b>                                                                                                                                                               | <b>(9)</b> |
| District Administration - Municipal Corporation - Zila Panchayat                                                                                                                                    |            |
| <b>UNIT V – Election Commission</b>                                                                                                                                                                 | <b>(9)</b> |
| Role and Functioning - Chief Election Commissioner - State Election Commission                                                                                                                      |            |
| <b>TOTAL (L:45) : 45 PERIODS</b>                                                                                                                                                                    |            |

**TEXT BOOK:**

1. Rajeev Bhargava, Ethics and Politics of the Indian Constitution, Oxford University Press, New Delhi, 2008.
2. B.L. Fadia, The Constitution of India, Sahitya Bhawan; New edition (2017).
3. DD Basu, Introduction to the Constitution of India, Lexis Nexis; Twenty-Third 2018 edition.

**REFERENCES:**

1. Steve Blank and Bob Dorf, The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company", K & S Ranch ISBN – 978-0984999392
2. Eric Ries, The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses", Penguin UK ISBN – 978-0670921607
3. Adrian J. Slywotzky with Karl Weber, Demand: Creating What People Love Before They Know They Want It, Headline Book Publishing ISBN – 978-0755388974
4. Clayton M. Christensen, The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business, Harvard business ISBN: 978-142219602.

**REFERENCES: Web link**

1. <https://www.fundable.com/learn/resources/guides/startup>
2. <https://corporatefinanceinstitute.com/resources/knowledge/finance/corporate-structure/>
3. <https://www.finder.com/small-business-finance-tips>
4. <https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-business/>

| Mapping of COs with POs / PSOs |     |   |   |   |   |          |          |   |          |    |          |      |   |
|--------------------------------|-----|---|---|---|---|----------|----------|---|----------|----|----------|------|---|
| COs                            | POs |   |   |   |   |          |          |   |          |    |          | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6        | 7        | 8 | 9        | 10 | 11       | 1    | 2 |
| 1                              |     |   |   |   |   | 3        | 3        |   | 2        |    | 3        |      |   |
| 2                              |     |   |   |   |   | 3        | 3        |   | 2        |    | 3        |      |   |
| 3                              |     |   |   |   |   | 3        | 3        |   | 2        |    | 3        |      |   |
| 4                              |     |   |   |   |   | 3        | 3        |   | 2        |    | 3        |      |   |
| 5                              |     |   |   |   |   | 3        | 3        |   | 2        |    | 3        |      |   |
| <b>CO (W.A)</b>                |     |   |   |   |   | <b>3</b> | <b>3</b> |   | <b>2</b> |    | <b>3</b> |      |   |



| <b>22MEC09 - THERMAL ENGINEERING SYSTEMS</b><br>(Use of Steam Tables is permitted) |                                                                                                                                                                                                                                                      |                        |                                                     |          |
|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                                                    |                                                                                                                                                                                                                                                      | <b>L</b>               | <b>T</b>                                            | <b>P</b> |
|                                                                                    |                                                                                                                                                                                                                                                      | <b>3</b>               | <b>1</b>                                            | <b>0</b> |
| <b>PREREQUISITE : 22MEC04</b>                                                      |                                                                                                                                                                                                                                                      |                        |                                                     |          |
| <b>Course Objective:</b>                                                           | <ul style="list-style-type: none"> <li>To determine the number of stages/plates required.</li> <li>To provide a in the basic principles of thermodynamics and heat transfer, enabling students to understand and analyze thermal systems.</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to                              |                                                                                                                                                                                                                                                      | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                                                | Apply the basic principles of IC engines and auxiliary systems to explain their operation and performance                                                                                                                                            | Ap                     | 40%                                                 |          |
| CO2                                                                                | Apply the principles of boiler operation and nozzle flow to determine efficiency and performance.                                                                                                                                                    | Ap                     | 20%                                                 |          |
| CO3                                                                                | Apply steam cycle and turbine concepts to analyze power generation systems.                                                                                                                                                                          | Ap                     | 20%                                                 |          |
| CO4                                                                                | Apply refrigeration and air conditioning concepts to assess system behavior and component performance.                                                                                                                                               | Ap                     | 20%                                                 |          |
| CO5                                                                                | Analyze the functional relationships and procedures involved in assembling and dismantling components of thermal engineering systems.                                                                                                                | An                     | Internal Assessment                                 |          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                             |              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>UNIT I - INTERNAL COMBUSTION ENGINES – FUNDAMENTALS AND COMBUSTIONS</b>                                                                                                                                                                                                                                                                                                                                                                  | <b>(9+3)</b> |
| IC engine – Classification, working, components and their functions. Ideal and actual : Valve and port timing diagrams, p-v diagrams- two stroke & four stroke, and SI & CI engines – comparison. Geometric, operating, and performance comparison of SI and CI engines. Desirable properties and qualities of fuels. Air-fuel ratio calculation – lean and rich mixtures. Combustion in SI & CI Engines – Knocking – phenomena and control |              |
| <b>UNIT II - INTERNAL COMBUSTION ENGINES - PERFORMANCES AND AUXILIARY SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                           | <b>(9+3)</b> |
| Performance and Emission Testing, Performance parameters and calculations. Morse and Heat Balance tests. Multipoint Fuel Injection system and Common rail direct injection systems. Ignition systems – Magneto, Battery and Electronic. Lubrication and Cooling systems. Concepts of Supercharging and Turbo charging – Emission Norms                                                                                                      |              |
| <b>UNIT III - STEAM BOILERS AND NOZZLES</b>                                                                                                                                                                                                                                                                                                                                                                                                 | <b>(9+3)</b> |
| Classifications – comparison - Fire tube boiler and water tube boiler – simple vertical, Cochran boiler, Locomotive, Babcock and Wilcox boilers – High pressure boiler – Lamont boiler and Loeffler boiler – Steam nozzle – convergent and divergent nozzle - steam flow through nozzles – nozzle efficiency – Metastable expansion of steam in a nozzle                                                                                    |              |
| <b>UNIT IV - STEAM POWER CYCLES AND STEAM TURBINE</b>                                                                                                                                                                                                                                                                                                                                                                                       | <b>(9+3)</b> |
| Steam Power Cycles - Carnot Cycle - Rankine Cycle - Modified Rankine Cycle - Regenerative Cycle - Steam Turbine - Classifications – working - Impulse and reaction turbine – Compounding – velocity diagram of impulse turbine                                                                                                                                                                                                              |              |

|                                                                                                                                                                                                                                                                                                             |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>UNIT V - REFRIGERATION AND AIR CONDITIONING</b>                                                                                                                                                                                                                                                          | <b>(9+3)</b> |
| Fundamentals of refrigeration - COP - simple vapour compression system – Effect of super heating, Effect of sub cooling - working principle of vapour absorption system - refrigerants, classification, properties - air conditioning systems- summer, winter, year round air conditioning - central system |              |
| <b>TOTAL (L:45+T:15) : 60 PERIODS</b>                                                                                                                                                                                                                                                                       |              |

|                                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                     |
| 1. Rajput.R.K, “Thermal Engineering”, 11 <sup>th</sup> Edition., Laxmi Publications Ltd, 2020                          |
| 2. Ganesan V, Internal Combustion Engines, 4 <sup>th</sup> Edition, McGraw-Hill companies, 2017                        |
| <b>REFERENCES:</b>                                                                                                     |
| 1. Ba Ilaney. P.L “Thermal Engineering”, 25 <sup>th</sup> Edition, Khanna Publishers, 2017.                            |
| 2. Manohar Prasad, “Refrigeration and Air Conditioning”, 3 <sup>rd</sup> ed., New Age International publications, 2021 |
| 3. Arora C P, “Refrigeration and Air Conditioning”, 4 <sup>th</sup> Edition., Tata McGraw - Hill Education, 2021       |
| 4. Rudramoorthy.R, “Thermal Engineering”, Tata McGraw-Hill, New Delhi, 2017                                            |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   | 3 |   |   |   |    |    |      |   |
| 2                              |     |   |   |   |   | 3 |   |   |   |    |    | 3    |   |
| 3                              | 3   | 3 |   |   |   | 3 |   |   |   |    |    | 3    |   |
| 4                              |     | 3 | 3 |   |   | 3 |   |   |   |    |    | 3    |   |
| 5                              |     |   |   |   |   |   |   | 3 | 3 | 3  |    |      |   |
| CO (W.A)                       | 3   | 3 | 3 |   |   | 3 |   | 3 | 3 | 3  |    | 3    |   |

| 22MECI0 – SUBTRACTIVE MANUFACTURING PROCESSES         |                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                     |          |          |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|----------|----------|
|                                                       |                                                                                                                                                  | <b>L</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>T</b>                                            | <b>P</b> | <b>C</b> |
|                                                       |                                                                                                                                                  | <b>3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>0</b>                                            | <b>0</b> | <b>3</b> |
| <b>PREREQUISITE : 22MEC06</b>                         |                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                     |          |          |
| <b>Course Objective:</b>                              |                                                                                                                                                  | <ul style="list-style-type: none"><li>• To study the concepts and basic mechanics of metal cutting and the factors affecting machinability</li><li>• To learn working of basic and advanced turning machines.</li><li>• To apply the working of machine namely shaping, planning, slotting and different drilling machines.</li><li>• To study the basic concepts of CNC of machine tools and constructional features of CNC.</li><li>• To learn the basics of CNC programming concepts to develop the part Programme for Machine centre and turning centre.</li></ul> |                                                     |          |          |
| <b>Course Outcomes</b><br>The Student will be able to |                                                                                                                                                  | <b>Cognitive Level</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Weightage of COs in End Semester Examination</b> |          |          |
| CO1                                                   | Apply the mechanism of metal removal process.                                                                                                    | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 20%                                                 |          |          |
| CO2                                                   | Identify the operational features in different types of lathe.                                                                                   | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 20%                                                 |          |          |
| CO3                                                   | Evaluating the different types of operating in reciprocating machines/ revolving machines.                                                       | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 40%                                                 |          |          |
| CO4                                                   | Demonstrate the Program for CNC machine tools through planning, writing codes and setting up CNC machine tools to manufacture a given component. | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 20%                                                 |          |          |
| CO5                                                   | Develop a project based learning by identifying the suitable materials and subtractive manufacturing process as a member/ team.                  | Cr                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Internal Assessment                                 |          |          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - THEORY OF METAL CUTTING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>(9)</b> |
| Mechanics of chip formation, forces in machining, Types of chip, cutting tools – single point cutting tool nomenclature, orthogonal and oblique metal cutting, thermal aspects, cutting tool materials, tool wear, tool life, surface finish, cutting fluids and Machinability                                                                                                                                                                                                                           |            |
| <b>UNIT II - TURNING MACHINES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>(9)</b> |
| Centre lathe, constructional features, specification, operations – taper turning methods, thread cutting methods, special attachments, surface roughness in turning, machining time and power estimation. Special lathes - Capstan and turret lathes- tool layout – automatic lathes: semi-automatic – single spindle: Swiss type, automatic screw type – multi spindle                                                                                                                                  |            |
| <b>UNIT III - RECIPROCATING MACHINE TOOLS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Reciprocating machine tools: shaper, planer, slotter: Types and operations- Hole making: Drilling, reaming, boring, tapping, type of milling operations-attachments- types of milling cutters– machining time calculation- Gear cutting, gear hobbing and gear shaping – gear finishing methods Abrasive processes: grinding wheel – specifications and selection, types of grinding process – cylindrical grinding, surface grinding, centerless grinding, internal grinding - micro finishing methods. |            |
| <b>UNIT IV - CNC MACHINES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Computer Numerical Control (CNC) machine tools, constructional details, special features – Drives, Recirculating ball screws, tool changers; CNC Control systems – Open/closed, point-to-point/continuous- Turning and machining centres – Work holding methods in Turning and machining centres, Coolant systems, Safety features.                                                                                                                                                                      |            |

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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT V - PROGRAMMING OF CNC MACHINE TOOLS</b>                                                                                                                                                                                                                               | <b>(9)</b> |
| Coordinates, axis and motion, Absolute vs Incremental, Interpolators, Polar coordinates, Program planning, G and M codes, Manual part programming for CNC machining centers and Turning centers – Fixed cycles, Loops and subroutines, Setting up a CNC machine for machining. |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                               |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <ol style="list-style-type: none"> <li>1. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India, 4th Edition, 2013</li> <li>2. P.N .Rao Manufacturing Technology Volume I McGrawhill Education 5th edition, 2018.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <ol style="list-style-type: none"> <li>1. HajraChoudhury S.K, HajraChoudhury A.K and Nirjhar Roy, “Elements of Workshop Technology”, Vol. I, 2017</li> <li>2. HMT, “Production Technology”, “McGraw Hill Education”, 2017</li> <li>3. Sharma.P.C, “A Textbook of Production Technology”, S. Chand Publications, 2014</li> <li>4. S. Gowri P. Hariharan, A.SureshBabu, Manufacturing Technology I, Pearson Education, 2008.</li> <li>5. Ro y. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.</li> <li>6. Rajput.R.K, “A Textbook of Manufacturing Technology”, 2nd ed., Laxmi Publications (P) Ltd, 2016</li> </ol> |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   | 3 |    |    | 3    |   |
| 2                              |     |   |   |   |   |   |   |   |   | 2  |    |      |   |
| 3                              |     | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 4                              |     |   |   |   |   | 3 |   |   |   |    |    |      |   |
| 5                              |     |   | 3 |   |   |   |   |   |   |    | 3  |      |   |
| CO (W.A)                       | 3   | 3 | 3 |   |   | 3 |   |   | 3 | 2  | 3  | 3    |   |



| 22MECI I - STRENGTH OF MATERIALS                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                        |                                                     |          |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>L</b>               | <b>T</b>                                            | <b>P</b> |
|                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>3</b>               | <b>0</b>                                            | <b>2</b> |
| <b>PREREQUISITE : NIL</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                        |                                                     |          |
| <b>Course Objective:</b>                              | <ul style="list-style-type: none"> <li>To provide knowledge about stress distribution and strain in regular and composite structures subjected to axial loads</li> <li>To familiarize about bi-axial stress systems and stresses in thin cylinders</li> <li>To give input on shear force, bending moment diagrams and evaluate the bending stress in different beams under transverse loading</li> <li>To impart knowledge on finding slope and deflection of beams and buckling of columns for different boundary conditions</li> <li>To provide awareness on stresses on shafts and helical springs based on theory of torsion</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                   | Analyze stress and strain responses in structural elements under axial and biaxial loading conditions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | An                     | 40%                                                 |          |
| CO2                                                   | Apply the concepts of shear force and bending moment to determine stresses in beams.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Ap                     | 20%                                                 |          |
| CO3                                                   | Analyze beam deflection and column buckling using appropriate engineering methods.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | An                     | 20%                                                 |          |
| CO4                                                   | Apply torsion and spring equations to solve problems related to circular shafts and helical springs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Ap                     | 20%                                                 |          |
| CO5                                                   | Conduct investigation on engineering materials based on the principles of solid mechanics while working as a member of a team/individual                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | An                     | Internal Assessment                                 |          |

|                                                                                                                                                                                                                                                                                                                               |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I: STRESSES AND STRAIN</b>                                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Introduction to material properties, Stress-strain curve for ductile and brittle materials, Hooke's law, Stresses and strain due to axial force in Stepped and Composite bars, Stresses due to thermal effect in composite bars, Factor of safety, Poisson-ratio, Volumetric strain, Elastic constants and their relationship |            |
| <b>UNIT II: BI-AXIAL STRESS SYSTEM</b>                                                                                                                                                                                                                                                                                        | <b>(9)</b> |
| State of stresses at a point, Normal and shear stresses on inclined planes, Principal planes and Principal stresses, Plane of maximum shear stress, Mohr's circle for bi-axial stress with shear stress. Hoop and longitudinal stresses in thin cylindrical vessels, Maximum Shear stress, Changes in dimensions and volume.  |            |
| <b>UNIT III: SHEAR FORCE, BENDING MOMENT AND STRESSES IN BEAMS</b>                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Types of beams, supports and Loads, Shear force and Bending Moment diagram of Cantilever, simply supported and overhanging beams, Point of contra flexure. Theory of Simple Bending, Bending stress.                                                                                                                          |            |
| <b>UNIT IV: DEFLECTION OF BEAMS AND COLUMNS</b>                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Slope and Deflection of cantilever and simply supported beams by Double integration method and Macaulay's method. Types of Columns, Equivalent length, Euler and Rankine's formulae, Slenderness ratio                                                                                                                        |            |
| <b>UNIT V: TORSION IN SHAFT AND HELICAL SPRING</b>                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Torsion equation - stresses and deformations in circular solid, circular hollow and stepped shafts - Closed coil helical spring-stresses and deflection under axial load.                                                                                                                                                     |            |

**LIST OF EXPERIMENTS**

1. Study of Stress / Strain curves for various materials
2. Tension test on steel rod
3. Double shear test in UTM
4. Rockwell Hardness test
5. Brinell Hardness Test
6. Izod impact test
7. Deflection test on Steel beam
8. Deflection test on Wooden beam
9. Compression test on Bricks
10. Compression test on helical spring

**TOTAL (L:45 + P:30): 75 PERIODS****TEXT BOOKS:**

1. Bansal R.K, "A textbook of Strength of Materials: (Mechanics of Solids) SI Units", 6<sup>th</sup>Edition, Laxmi Publications, 2017
2. Ferdinand Beer Jr., E. Russell Johnston Jr., John T. DeWolf and David F. Mazurek, "Mechanics of Materials", 7<sup>th</sup>Edition, McGraw Hill, 2011

**REFERENCES:**

1. S.S. Rattan, Strength of Materials, McGraw Hill Education (India) Private Limited, Chennai, 3<sup>rd</sup> Edition, 2017
2. S.S. Bhavikatti, Strength of Materials, Vikas Publishing House, New Delhi, 4<sup>th</sup> Edition, 2013
3. Egor P. Popov, Engineering Mechanics of Solids, Pearson India Education Services Pvt. Ltd., New Delhi, 2015
4. Ramamrutham S and Narayanan R, "Strength of Materials", DhanpatRai Publications, 2017
5. Rajput R.K, "Strength of Materials", 6<sup>th</sup>Edition, S.Chand and Company Ltd., 2015

**Mapping of COs with POs / PSOs**

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | I   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | I    | 2 |
| 1        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 2        |     | 3 |   |   |   |   |   |   |   |    |    | 3    |   |
| 3        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 4        |     | 3 |   |   |   |   |   |   |   |    |    | 3    |   |
| 5        |     |   |   | 2 |   |   |   | I | I |    |    | 3    |   |
| CO (W.A) | 3   | 3 |   | 2 |   |   |   | I | I |    |    | 3    |   |



| 22MECI2 - THEORY OF MACHINES                          |                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                     |          |          |
|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|----------|----------|
|                                                       |                                                                                                                                                | <b>L</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>T</b>                                            | <b>P</b> | <b>C</b> |
|                                                       |                                                                                                                                                | <b>3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>0</b>                                            | <b>2</b> | <b>4</b> |
| <b>PREREQUISITE : NIL</b>                             |                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                     |          |          |
| <b>Course Objective:</b>                              |                                                                                                                                                | <ul style="list-style-type: none"><li>• To know the basic components and velocity / acceleration analysis of mechanisms</li><li>• To understand the basic concepts of toothed gearing and kinematics of gear trains</li><li>• To acquire knowledge on cam mechanisms for specified output motions and the effects of friction in machine elements.</li><li>• To introduce the concepts of static and dynamic force analysis in mechanisms and reciprocating engines</li><li>• To learn the balancing concepts of rotating and reciprocating masses and the various types of vibrations</li></ul> |                                                     |          |          |
| <b>Course Outcomes</b><br>The Student will be able to |                                                                                                                                                | <b>Cognitive Level</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>Weightage of COs in End Semester Examination</b> |          |          |
| CO1                                                   | Apply the concepts of mechanism terminology, degrees of freedom, and Grashof's Law in kinematic inversions of mechanisms.                      | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 20%                                                 |          |          |
| CO2                                                   | Apply the law of toothed gearing concepts and applications in kinematics gears and gear trains.                                                | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 20%                                                 |          |          |
| CO3                                                   | Design the cam profiles for various follower motions and evaluate friction drives, including plate clutches and belt drives,                   | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 20%                                                 |          |          |
| CO4                                                   | Analyze the static and dynamic forces in mechanisms and reciprocating engines.                                                                 | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 20%                                                 |          |          |
| CO5                                                   | Apply the balancing concepts in reciprocating and rotating masses to solve problems; and Compute the frequency of various types of vibrations. | AP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 20%                                                 |          |          |

|                                                                                                                                                                                                                                                                                                                                                                                                |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT - I KINEMATICS OF MECHANISMS AND ANALYSIS</b>                                                                                                                                                                                                                                                                                                                                          | <b>(9)</b> |
| Mechanisms – Terminology and definitions – Degree freedom of simple mechanism – Grashof's Law - Kinematic Inversions of Four bar chain, Single slider and Double slider crank chains –kinematics Analysis in slider crank mechanism - Velocity and Acceleration- Analytical method.                                                                                                            |            |
| <b>UNIT – II GEARS AND GEAR TRAINS</b>                                                                                                                                                                                                                                                                                                                                                         | <b>(9)</b> |
| Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains                                                                                                                                   |            |
| <b>UNIT- III KINEMATICS OF CAMS AND FRICTION DRIVES</b>                                                                                                                                                                                                                                                                                                                                        | <b>(9)</b> |
| Classifications of Cams and Followers - Displacement diagrams for uniform velocity, simple harmonic motion, constant acceleration and deceleration, cycloidal motions - Graphical layout of radial cam profile with in-line knife edge follower- tangent cam and circular arc cam. Friction- Surface contacts – Sliding and Rolling friction- Friction drives – Plate clutches and belt drive. |            |
| <b>UNIT – IV FORCE ANALYSIS</b>                                                                                                                                                                                                                                                                                                                                                                | <b>(9)</b> |
| Static force analysis - static equilibrium conditions - free body diagrams - static Equilibrium conditions – Two, Three and four members - graphical force analysis without friction for four bar mechanism and slider crank mechanism - Dynamic force analysis in Reciprocating Engines –D'Alembert's principle - analytical method of engine force analysis without inertia.                 |            |

| <b>UNIT – V BALANCING AND VIBRATION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>(9)</b> |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Static and Dynamic balancing - Balancing of rotating masses – balancing of reciprocating masses - tractive force, swaying couple, hammer blow – vibration- Free longitudinal and transverse vibrations – natural Frequency – Damped Vibration – critical speed of simple shaft –torsional vibrations on single and two rotor systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |            |
| <b>LIST OF EXPERIMENTS</b> <ol style="list-style-type: none"> <li>1. Determination of transmission angle and toggle position of four bar mechanisms.</li> <li>2. Determination of ratio of time of cutting stroke to return stroke and length of stroke of quick return mechanism.</li> <li>3. Experimental study of Gears, Gear trains and Differential unit.</li> <li>4. Determination of moment of inertia of an object by oscillation method.</li> <li>5. Determination of jump speed of the cam.</li> <li>6. Balancing of rotating mass of the shaft.</li> <li>7. Deflection of fixed –free cantilever beam.</li> <li>8. Determination of natural frequency of vibration of the spring mass system.</li> <li>9. Determination of whirling speed of shaft.</li> <li>10. Determination of natural frequency of the free torsional vibration of the single rotor system.</li> </ol> |            |
| <b>TOTAL (L:45 + P:30): 75 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            |

#### TEXT BOOK:

1. John J. Uicker, Jr., Gordon R. Pennock and Joseph E. Shigley, “Theory of Machines and Mechanisms - SI Edition”, 4th ed., Oxford University Press, 2017
2. Khurmi.R.S and Gupta.J.K, “Theory of Machines”, 15th ed., S.Chand & Company Pvt. Ltd., 2017

#### REFERENCES:

1. Rattan.S.S, “Theory of Machines”, 5th ed., McGraw Hill Education India Private Limited, 2019
2. Ambekar A.G, “Mechanism and Machine Theory”, 1st ed., Prentice Hall of India, 2013
3. Bansal.R.K and Brar.J.S, “Theory of Machines”, 5th ed., Laxmi Publications, Revised 2016
4. Ghosh A. and Mallick A.K., “Theory of Mechanisms and Machines”, East-West Publications, 2008
5. Kenneth J Waldron and Gary L Kinzel, “Kinematics, Dynamics, and Design of Machinery”, 3rd ed., Wiley India Pvt Ltd, 2016

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| Cos                            | Pos |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   | 2 |   |    |    | 3    |   |
| 2                              | 3   |   |   |   |   |   |   | 2 |   |    |    | 3    |   |
| 3                              |     |   | 3 |   |   |   |   | 2 |   |    |    | 3    |   |
| 4                              |     | 3 |   |   |   |   |   | 2 |   |    |    | 3    |   |
| 5                              | 3   |   | 3 |   |   |   |   | 2 |   |    |    |      |   |
| CO (W.A)                       | 3   | 3 | 3 |   |   |   |   | 2 |   |    |    | 3    |   |



| 22MEP03 - THERMAL ENGINEERING LABORATORY       |                                                                                                                                |                                                                                                                                                                                                                                                                                                                   |   |                 |   |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------|---|
|                                                |                                                                                                                                | L                                                                                                                                                                                                                                                                                                                 | T | P               | C |
|                                                |                                                                                                                                | 0                                                                                                                                                                                                                                                                                                                 | 0 | 4               | 2 |
| PREREQUISITE: NIL                              |                                                                                                                                |                                                                                                                                                                                                                                                                                                                   |   |                 |   |
| Course Objective:                              |                                                                                                                                | <ul style="list-style-type: none"><li>To analyze performance of internal combustion engines and compressor to assess their characteristics, efficiency, and work output.</li><li>To understand the working principles of refrigeration and air conditioning systems and to determine their performance.</li></ul> |   |                 |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                |                                                                                                                                                                                                                                                                                                                   |   | Cognitive Level |   |
| CO1                                            | Evaluate the flash point, fire point, and viscosity of fuels and understanding their significance in engine performance.       |                                                                                                                                                                                                                                                                                                                   |   | Ev              |   |
| CO2                                            | Conduct performance tests on compression ignition engines and interpret the results.                                           |                                                                                                                                                                                                                                                                                                                   |   | Ap              |   |
| CO3                                            | Perform Morse tests on multi-cylinder engines to determine power outputs of individual cylinder and overall engine efficiency. |                                                                                                                                                                                                                                                                                                                   |   | An              |   |
| CO4                                            | Evaluate the performance characteristics of a reciprocating air compressor through experimental analysis.                      |                                                                                                                                                                                                                                                                                                                   |   | Ev              |   |
| CO5                                            | Conduct performance tests on refrigeration systems to determine coefficient of performance (COP).                              |                                                                                                                                                                                                                                                                                                                   |   | Ev              |   |

| <b>PART I IC ENGINES LABORATORY</b>                                                                                                                                                                                                                                                                                                                                                             |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>List of Experiments</b>                                                                                                                                                                                                                                                                                                                                                                      |  |
| <b>CYCLE - I</b>                                                                                                                                                                                                                                                                                                                                                                                |  |
| <ol style="list-style-type: none"> <li>Valve timing and Port Timing Diagrams</li> <li>Determination of flash point, fire point and viscosity of fuels</li> <li>Performance test on C.I engines</li> <li>Morse test on multi cylinder engine</li> <li>Determination of Frictional power using retardation test</li> <li>Heat balance test on C.I engines with Data Acquisition system</li> </ol> |  |
| <b>CYCLE - II</b>                                                                                                                                                                                                                                                                                                                                                                               |  |
| <ol style="list-style-type: none"> <li>Performance test on air blower</li> <li>Performance test on reciprocating air compressor</li> <li>Measurement of lift and drag force of an aero foil model</li> <li>Performance test on air conditioning system.</li> <li>Performance test on Refrigeration system.</li> <li>Study of Steam Generators and Turbines.</li> </ol>                          |  |
| <b>TOTAL: 60 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                        |  |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   | 2 | 2 |   |   | 2 |   |   |   |    |    |      |   |
| 2                              | 3   | 2 | 2 |   |   |   |   |   |   |    |    |      |   |
| 3                              | 3   | 2 | 2 |   |   |   |   |   |   |    |    |      |   |
| 4                              | 3   | 2 | 2 |   |   |   |   |   |   |    |    | 2    |   |
| 5                              | 3   | 2 | 2 |   |   | 2 |   |   |   |    |    | 2    |   |
| CO (W.A)                       | 3   | 2 | 2 |   |   | 2 |   |   |   |    |    | 2    |   |



| 22MEP04 - SUBTRACTIVE MANUFACTURING PROCESSES LABORATORY |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                 |   |   |
|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------|---|---|
|                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | L | T               | P | C |
|                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0 | 0               | 4 | 2 |
| PREREQUISITE : NIL                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                 |   |   |
| Course Objective:                                        | <ul style="list-style-type: none"><li>• To carry out machining operations in lathe machines.</li><li>• To understand the methods of calculating cutting forces.</li><li>• To gain skills in performing shaping, slotting, milling, grinding machine, gear hobbing.</li><li>• To acquire knowledge on the cutting forces, average chip-temperature and surface finish during metal removal processes.</li><li>• To understand the effect of process parameters on material removal processes.</li></ul> |   |                 |   |   |
| Course Outcomes<br>The Student will be able to           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   | Cognitive Level |   |   |
| CO1                                                      | Apply the machining of cylindrical and prismatic parts using metal removal processes.                                                                                                                                                                                                                                                                                                                                                                                                                  |   | Ap              |   |   |
| CO2                                                      | Estimate the cutting forces in machining operations of different materials.                                                                                                                                                                                                                                                                                                                                                                                                                            |   | An              |   |   |
| CO3                                                      | Develop gear model by using gear generation and gear hobbing processes.                                                                                                                                                                                                                                                                                                                                                                                                                                |   | An/Cr           |   |   |
| CO4                                                      | Identify the process parameters for machining various materials.                                                                                                                                                                                                                                                                                                                                                                                                                                       |   | An              |   |   |
| CO5                                                      | Design and develop a given components into finished components in subtractive manufacturing processes as a member of a team/ individual.                                                                                                                                                                                                                                                                                                                                                               |   | Cr              |   |   |

#### LIST OF EXPERIMENTS :

1. Fabricating simple structural shapes using Gas and Arc Welding machine
2. Preparing green sand moulds with cast patterns.
3. Conversion of round rod into square/hexagonal rod using forging.
4. Taper Turning, External Thread Cutting & Knurling on circular parts using lathe machine.
5. Eccentric Turning on circular parts using lathe machine.
6. Shaping – Square and Hexagonal Heads on circular parts using shaper machine.
7. Drilling and Reaming using vertical drilling machine.
8. Milling contours on plates using vertical milling machine.
9. Cutting spur and helical gear using horizontal milling machine.
10. Generating gears using gear hobbing machine.
11. Grinding components using cylindrical and centerless grinding machine.
12. Grinding components using surface grinding machine.
13. Cutting force calculation using dynamometer in milling machine.
14. Cutting force calculation using dynamometer in lathe machine.

**TOTAL (P:60) = 60 PERIODS**

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   | 3 |   |    |    | 3    |   |
| 2                              |     |   | 3 |   |   |   |   |   |   |    |    |      |   |
| 3                              |     | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 4                              |     |   |   |   |   |   |   |   |   |    |    |      |   |
| 5                              |     |   |   |   |   | 3 |   |   |   |    |    |      |   |
| CO<br>(W.A)                    | 3   | 3 | 3 |   |   | 3 |   | 3 |   |    |    | 3    |   |



| 22MAN07R - SOFT/ANALYTICAL SKILLS – III<br>(Common to All Branches) |                                                                                                                                                    |                                                                                                                                                                                                                |                                                       |          |
|---------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|----------|
|                                                                     |                                                                                                                                                    | <b>L</b>                                                                                                                                                                                                       | <b>T</b>                                              | <b>P</b> |
|                                                                     |                                                                                                                                                    | <b>I</b>                                                                                                                                                                                                       | <b>0</b>                                              | <b>2</b> |
| <b>PREREQUISITE : 22MAN04R</b>                                      |                                                                                                                                                    |                                                                                                                                                                                                                |                                                       |          |
| <b>Course Objective:</b>                                            |                                                                                                                                                    | <ul style="list-style-type: none"> <li>To improve language proficiency for personal or professional reasons</li> <li>To enhance students' mathematical problem-solving and critical thinking skills</li> </ul> |                                                       |          |
| <b>Course Outcomes</b><br>The Student will be able to               |                                                                                                                                                    | <b>Cognitive Level</b>                                                                                                                                                                                         | <b>Weightage of COs in Continuous Assessment Test</b> |          |
| CO1                                                                 | Demonstrate effective communication skills by listening actively, speaking clearly, reading critically, and writing coherently in contexts.        | U                                                                                                                                                                                                              | 40%                                                   |          |
| CO2                                                                 | Develop proficiency in applying mathematical concepts of time, speed, distance, and financial calculations involving simple and compound interest. | Ap                                                                                                                                                                                                             | 30%                                                   |          |
| CO3                                                                 | Analyse logical reasoning skills through various forms of statements.                                                                              | An                                                                                                                                                                                                             | 30%                                                   |          |

|                                                                                                                                                                                                                                                         |               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| <b>UNIT I – VERBAL ABILITY</b>                                                                                                                                                                                                                          | <b>(5+10)</b> |
| <b>Grammar</b> - Concord - Relative Clause - <b>Listening</b> - IELTS Listening (Advanced) and Gap Filling - <b>Speaking</b> - Introducing Others - Formal Conversations - <b>Reading</b> - Reading Comprehension - <b>Writing</b> - Hints Development. |               |
| <b>UNIT II – APTITUDE</b>                                                                                                                                                                                                                               | <b>(5+10)</b> |
| Simple and Compound Interest - Time, Speed and Distance - Problems on Trains - Boats and Streams - Chain Rule - Time and Work - Pipe and Cisterns.                                                                                                      |               |
| <b>UNIT III - REASONING</b>                                                                                                                                                                                                                             | <b>(5+10)</b> |
| Seating Arrangements - Syllogism - Statement and Conclusion - Statement and Assumption - Statement and Course of Action.                                                                                                                                |               |
| <b>TOTAL(L:45) = 45 PERIODS</b>                                                                                                                                                                                                                         |               |

| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Rizvi, M.Ashraf. Effective Technical Communication. Tata McGraw-Hill Education, 2017.<br>2. Aggarwal R S. Quantitative Aptitude for Competitive Examinations. S.Chand Publishing Company Ltd(s)., 2022.<br>3. Sharma, Arun. How to Prepare for Quantitative Aptitude for the CAT. Tata McGraw – Hill Publishing, 2022.<br>4. Praveen R V. <i>Quantitative Aptitude and Reasoning</i> . PHI Learning Pvt. Ltd., 2016. |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              |     |   |   |   |   |   |   | 2 | 3 |    |    |      |   |
| 2                              |     | 2 |   | 2 |   |   |   |   |   |    |    |      |   |
| 3                              |     | 2 |   | 2 |   |   |   |   |   |    |    |      |   |
| CO<br>(W.A)                    |     | 2 |   | 2 |   |   |   | 2 | 3 |    |    |      |   |

M. Y

| <b>22MAN06 ENVIRONMENTAL SCIENCE</b><br><b>(Common to AGRI (2nd semester) and MECH (4th semester) Branches)</b> |                                                                                                                                                                                                                                                                                                                                                                             |                        |                                                     |          |
|-----------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                                                                                 | <b>L</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>T</b>               | <b>P</b>                                            | <b>C</b> |
|                                                                                                                 | <b>2</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>0</b>               | <b>0</b>                                            | <b>0</b> |
| <b>PRE - REQUISITE : NIL</b>                                                                                    |                                                                                                                                                                                                                                                                                                                                                                             |                        |                                                     |          |
| <b>Course Objective:</b>                                                                                        | <ul style="list-style-type: none"> <li>To impart knowledge on ecosystem, biodiversity, environmental pollution and familiarize about sustainable development, carbon credit and green materials.</li> <li>To make the students conversant with the global and Indian scenario of renewable resources, causes of their degradation and measures to preserve them.</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to                                                           |                                                                                                                                                                                                                                                                                                                                                                             | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                                                                             | Illustrate the values and conservation methods of biodiversity                                                                                                                                                                                                                                                                                                              | Ap                     | Internal Assessment                                 |          |
| CO2                                                                                                             | Predict the causes, effects of environmental pollution and contribute the preventive measures to the society.                                                                                                                                                                                                                                                               | An                     |                                                     |          |
| CO3                                                                                                             | Produce the renewable and non-renewable resources and preserve them for future generations.                                                                                                                                                                                                                                                                                 | Ap                     |                                                     |          |
| CO4                                                                                                             | Organize the different goals of sustainable development and apply them for societal development.                                                                                                                                                                                                                                                                            | Ap                     |                                                     |          |
| CO5                                                                                                             | Evaluate the recycling of battery, cell phone , laptop and PCB                                                                                                                                                                                                                                                                                                              | E                      |                                                     |          |

|                                                                                                                                                                                                                                                                      |            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - ENVIRONMENT AND BIODIVERSITY</b>                                                                                                                                                                                                                         | <b>(6)</b> |
| Environment - scope and importance - Eco-system: Structure and function of an ecosystem- types of biodiversity - genetic - species and ecosystem diversity – values of biodiversity - hot-spots of biodiversity — conservation of biodiversity: In-situ and ex-situ. |            |
| <b>UNIT II - ENVIRONMENTAL POLLUTION</b>                                                                                                                                                                                                                             | <b>(6)</b> |
| Pollution – Causes - Effects and Preventive measures of Water, Air and noise pollution - Solid waste management: methods of disposal of solid waste - Environmental protection act: Air act – Water act.                                                             |            |
| <b>UNIT III - RENEWABLE SOURCES OF ENERGY</b>                                                                                                                                                                                                                        | <b>(6)</b> |
| Energy management and conservation - New Energy Sources: Different types of new energy sources – Solar energy – wind energy - Applications of Hydrogen energy, Ocean energy resources, Tidal energy conversion.                                                      |            |
| <b>UNIT IV – SUSTAINABILITY AND MANAGEMENT</b>                                                                                                                                                                                                                       | <b>(6)</b> |
| Development – Factors affecting development – advantages – disadvantages – GDP - Sustainability- needs – concept - concept of carbon credit – carbon footprint – Environmental management.                                                                           |            |
| <b>UNIT V – BATTERIES AND RECYCLING OF E-WASTE</b>                                                                                                                                                                                                                   | <b>(6)</b> |
| Battery lifecycle - Mobile battery life cycle – Laptop battery life cycle – battery maintenance – benefits of recycling battery – E-waste – sources of e-waste - recycling of computing devices - mobile phones - PCB .                                              |            |
| <b>TOTAL (L:30) : 30 PERIODS</b>                                                                                                                                                                                                                                     |            |

**TEXT BOOKS:**

1. Dr. A.Ravikrishnan, Environmental Science and Engineering., Sri Krishna Hitech Publishing co. Pvt.Ltd., Chennai, 15<sup>th</sup> Edition, 2023.
2. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers , 2018.

**REFERENCES:**

1. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
2. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

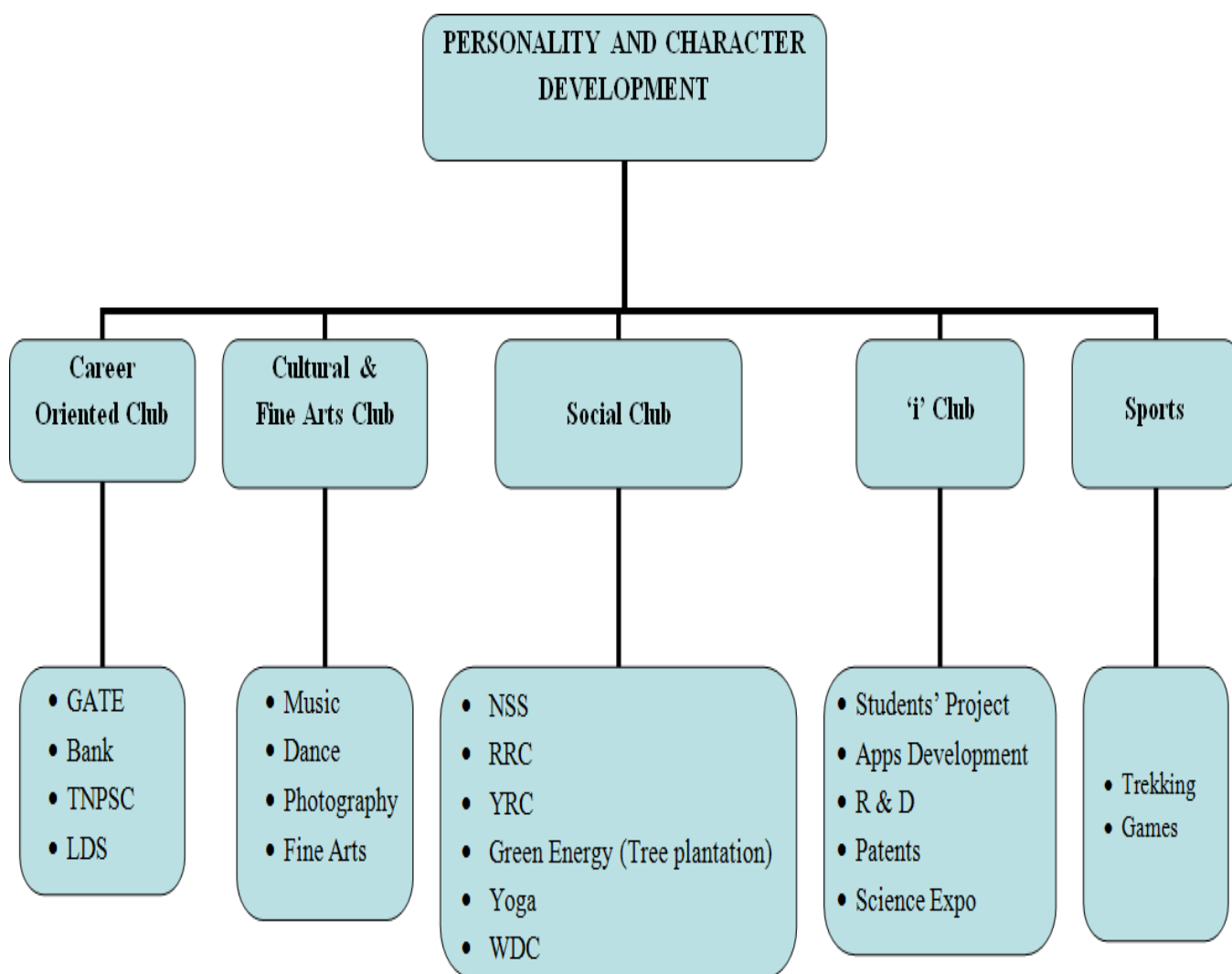
**WEBLINK:**

1. <http://www.jnkvv.org/PDF/08042020215128Amit1.pdf>
2. <https://www.conserve-energy-future.com/types-of-renewable-sources-of-energy.php>
3. <https://ugreen.io/sustainability-engineering-addressing-environmental-social-and-economic-issues/>
4. [https://www.researchgate.net/publication/326090368\\_E-Waste\\_and\\_Its\\_Management](https://www.researchgate.net/publication/326090368_E-Waste_and_Its_Management)
5. <https://www.ewaste1.com/how-to-reduce-e-waste/>

**Mapping of COs with POs / PSOs**

| COs             | POs      |          |          |   |   |          |          |          |   |    |          | PSOs |   |
|-----------------|----------|----------|----------|---|---|----------|----------|----------|---|----|----------|------|---|
|                 | 1        | 2        | 3        | 4 | 5 | 6        | 7        | 8        | 9 | 10 | 11       | 1    | 2 |
| 1               |          | 2        |          |   |   |          |          |          |   |    |          |      |   |
| 2               |          |          | 2        |   |   | 3        |          |          |   |    |          |      |   |
| 3               | 2        |          |          |   |   |          | 2        |          |   |    |          |      |   |
| 4               |          |          |          |   |   | 3        |          | 2        |   |    |          |      |   |
| 5               |          |          |          |   |   | 3        |          |          |   |    | 2        |      |   |
| <b>CO (W.A)</b> | <b>2</b> | <b>2</b> | <b>2</b> |   |   | <b>3</b> | <b>2</b> | <b>2</b> |   |    | <b>2</b> |      |   |





\*LDS - Leadership Development Skills

| OBJECTIVES :                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Career Oriented Club                                                                                                                                                                                      | Cultural & Fine Arts Club                                                                                                                                                                                                                                                                                                                                                                   | Social Club                                                                                                                                                                                                                                                                                                                                                                                                                                       | 'i' club                                                                                                                                                                                                                                                                                                                                        | Sports                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <ul style="list-style-type: none"> <li>•To provide support for identifying specific career field of interests and career path</li> <li>•To provide support for preparing for competitive exams</li> </ul> | <ul style="list-style-type: none"> <li>•To bring out the hidden talent of students in music, dance and other fine arts.</li> <li>•To promote photography skill among the students</li> <li>•To develop and enhance the performance of students by participating in various events</li> <li>•To inculcate managerial capabilities such as event management and stage organization</li> </ul> | <ul style="list-style-type: none"> <li>•To create social awareness and develop a sense of social and civic responsibility</li> <li>•To inculcate socially and environmentally sound practices and be aware of the benefits</li> <li>•To encourage the students to work along with the people in rural areas, thereby developing their character, social consciousness, commitment, discipline and being helpful towards the community.</li> </ul> | <ul style="list-style-type: none"> <li>•To inculcate the basic concepts of innovation</li> <li>•To foster the networking between students, build teams, exchange ideas, do projects and discuss entrepreneurial opportunities</li> <li>•To enrich the academic experience, build competencies and relationships beyond the classroom</li> </ul> | <ul style="list-style-type: none"> <li>•To provide opportunities to excel at sports</li> <li>•To promote an understanding of physical and mental well-being through an appreciation of stress, rest and relaxation.</li> <li>•To develop an ability to observe, analyze and judge the performance of self and peers in sporting activities.</li> <li>•To develop leadership skills and nurture the team building qualities.<br/><b><u>Trekking:</u></b></li> <li>•To provide opportunities to explore nature and educating about the purity of nature</li> <li>•To improve physical and mental health.</li> </ul> |

| <b>OUTCOMES</b> : At the end of this course, the students will be able to                                                                                                 |                                                                                                                                                   |                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>•Find a better career of their interest.</li> <li>•Make use of their knowledge during competitive exams and interviews.</li> </ul> | <ul style="list-style-type: none"> <li>•Take part in various events</li> <li>•Develop team spirit, leadership and managerial qualities</li> </ul> | <ul style="list-style-type: none"> <li>•Develop socially responsive qualities by applying acquired knowledge</li> <li>•Build character, social consciousness, commitment and discipline</li> </ul> | <ul style="list-style-type: none"> <li>•Apply the acquired knowledge in creating better solutions that meet new requirements and market needs</li> <li>•Develop skills on transforming new knowledge or new technology into viable products and services on commercial markets as a team</li> </ul> | <ul style="list-style-type: none"> <li>•Demonstrate positive leadership skills that contribute to the organizational effectiveness</li> <li>•Take part an active role in their personal wellness (emotional, physical, and spiritual) that supports a healthy lifestyle</li> <li>•Create inclination towards outdoor activity like nature study and Adventure.</li> </ul> |

**TOTAL [2 x (P: 15)]: 30 PERIODS**

**(Cumulatively for Two Semesters)**



| 22MECI4 - MACHINE DESIGN                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                        |                                                     |          |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>L</b>               | <b>T</b>                                            | <b>P</b> |
|                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>3</b>               | <b>1</b>                                            | <b>0</b> |
| <b>PREREQUISITE : NIL</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                        |                                                     |          |
| <b>Course Objective:</b>                              | <ul style="list-style-type: none"> <li>To introduce the design methodology of machine elements</li> <li>To acquire knowledge on analysis of forces acting on the machine elements and appropriate design methodology</li> <li>To analyse the stresses acting on the temporary and permanent joints</li> <li>To gain knowledge about the design of couplings and/or springs</li> <li>To teach various standards, and selection procedures of machine elements</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                   | Apply concepts of strength of materials to estimate the stresses in a machine element and predict failure of components.                                                                                                                                                                                                                                                                                                                                                | Ap                     | 20%                                                 |          |
| CO2                                                   | Analyse the effect of fatigue load on machine elements and factors affecting it to predict failure.                                                                                                                                                                                                                                                                                                                                                                     | An                     | 20%                                                 |          |
| CO3                                                   | Design the various joints such as temporary joints, permanent joints.                                                                                                                                                                                                                                                                                                                                                                                                   | An                     | 20%                                                 |          |
| CO4                                                   | Design the machine elements such as springs ,bearings and couplings                                                                                                                                                                                                                                                                                                                                                                                                     | An                     | 40%                                                 |          |
| CO5                                                   | Apply modern engineering tools along with relevant standards, codes, and regulations to design and analyze machine components effectively.                                                                                                                                                                                                                                                                                                                              | Ap                     | Internal Assessment                                 |          |

|                                                                                                                                                                                                                                                                                                                                                                                                                   |              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>UNIT I : STRESSES IN MACHINE ELEMENTS</b>                                                                                                                                                                                                                                                                                                                                                                      | <b>(9+3)</b> |
| Procedure in design process - factors influencing machine design - selection of materials based on mechanical properties preferred numbers, fits and tolerance - direct, bending and torsional stress equation - Modes of failure- bending stress incurved beams - crane hook and 'C' frame - factor of safety - theories of failures                                                                             |              |
| <b>UNIT II : VARIABLE STRESSES AND DESIGN OF SHAFTS</b>                                                                                                                                                                                                                                                                                                                                                           | <b>(9+3)</b> |
| Variable stresses in machine parts - stress concentration factor - cyclic stresses - fatigue and endurance limit - Goodman and Soderberg methods - combined normal stress and variable stress - design of solid and hollow shafts based on strength and rigidity                                                                                                                                                  |              |
| <b>UNIT III : PERMANENT AND TEMPORARY JOINTS</b>                                                                                                                                                                                                                                                                                                                                                                  | <b>(9+3)</b> |
| Welded joints - types - basic weld symbols - strength of transverse and parallel fillet welded joints - eccentrically loaded welded joints. Threaded joints - terms - forms - design of bolted joints under eccentric loading - introduction to riveted joints                                                                                                                                                    |              |
| <b>UNIT IV : DESIGN OF COUPLINGS AND SPRINGS</b>                                                                                                                                                                                                                                                                                                                                                                  | <b>(9+3)</b> |
| Couplings - types - design of muff coupling, unprotected type flange coupling, bushed pin flexible coupling - Introduction to ELBO flexible pin-type coupling, springs- types, helical springs, materials, end connections, terms used in compression springs - stresses and deflection in helical springs of circular wire - surge in springs - design of leaf springs - stress and deflection equation, nipping |              |
| <b>UNIT V : BEARINGS</b>                                                                                                                                                                                                                                                                                                                                                                                          | <b>(9+3)</b> |
| Sliding contact bearings – theory of lubrication, hydrodynamic bearings, Sommerfield number – design of hydrodynamic bearings – rolling contact bearings, static and dynamic load capacity, cubic mean load, variable load, probability of survival, selection of deep groove ball bearing, Introduction to Magnetic bearings and its applications.                                                               |              |

| S. No. | Practice Titles     | Unit |
|--------|---------------------|------|
| 1      | Fits and Tolerances | 1    |
| 2      | Welded joints       | 3    |
| 3      | Helical Springs     | 4    |

**TOTAL : 60 Hours (45 L +15 T)**

#### TEXT BOOKS

3. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 10th ed., McGraw-Hill Education, 2015
4. Bhandari V.B, “Design of Machine Elements”, 4th ed., McGraw Hill Education India Private Limited, 2017

#### REFERENCES:

1. Khurmi. R.S and Gupta. J. K, “A Textbook of Machine Design”, S. Chand and Company Ltd., New Delhi, 2014
2. Jalaludeen S.Md, “Machine Design (Volume-I)”, 4th ed., Anuradha Publications, Chennai, 2011
3. Sundararajamoorthy T. V. Shanmugam. N, “Machine Design”, Anuradha Publications, Chennai, 2003
4. Robert C. Juvinall, Kurt M. Marshek, “Machine Component Design”, Wiley India Pvt Ltd., 2016
5. Ganesh Babu.K, Srithar.K, “Design of Machine Elements”, 2nd ed., McGraw Hill Education (India) Private Limited, 2009

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 2                              |     | 3 |   |   |   |   |   |   |   |    |    | 3    |   |
| 3                              |     |   | 3 |   |   |   |   |   |   |    |    | 3    |   |
| 4                              |     |   | 3 |   |   |   |   |   |   |    |    | 3    |   |
| 5                              | 3   |   |   |   |   |   | 2 |   |   |    |    |      | 2 |
| CO (W.A)                       | 3   | 3 | 3 |   |   |   | 2 |   |   |    |    | 3    | 2 |

| 22MECI5 - METROLOGY AND MEASUREMENTS                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|------------|
|                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>L</b>               | <b>T</b>                                            | <b>P</b>   |
|                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>3</b>               | <b>0</b>                                            | <b>0</b>   |
| <b>PREREQUISITE :</b>                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |            |
| <b>Course Objective:</b>                                                                                                                                                                                                                                                                                                                          | <ul style="list-style-type: none"> <li>To introduce the principles of metrology and measurements</li> <li>To acquire knowledge on measurement parameters and its applications</li> <li>To acquire knowledge on the concept of various measurements like linear and angular measurements</li> <li>To impart knowledge on statistical measurements and surface finish</li> <li>To gain knowledge on laser and advances in metrology system</li> </ul> |                        |                                                     |            |
| <b>Course Outcomes</b><br>The Student will be able to                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |            |
| CO1                                                                                                                                                                                                                                                                                                                                               | Apply the concepts of measurement systems to identify and evaluate the performance characteristics of measuring instruments                                                                                                                                                                                                                                                                                                                         | Ap                     | 20%                                                 |            |
| CO2                                                                                                                                                                                                                                                                                                                                               | Apply appropriate measurement techniques for mechanical parameters and select suitable instruments for specific industrial applications                                                                                                                                                                                                                                                                                                             | Ap                     | 20%                                                 |            |
| CO3                                                                                                                                                                                                                                                                                                                                               | Analyze various linear, angular, and form measurement techniques to interpret dimensional and geometric accuracy of engineering components                                                                                                                                                                                                                                                                                                          | An                     | 40%                                                 |            |
| CO4                                                                                                                                                                                                                                                                                                                                               | Apply advanced metrology tools to perform precision measurements for quality control in industrial applications                                                                                                                                                                                                                                                                                                                                     | Ap                     | 20%                                                 |            |
| CO5                                                                                                                                                                                                                                                                                                                                               | Engage in independent study as a member of a team or individual and make effective oral presentation on measurement systems                                                                                                                                                                                                                                                                                                                         | U                      | Internal Evaluation                                 |            |
| <b>UNIT I : MEASUREMENT SYSTEMS</b>                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     | <b>(9)</b> |
| General concept - units and standards - characteristics of measuring instruments - sensitivity, stability, range, accuracy and precision - static and dynamic response - repeatability, hysteresis - systematic and random errors - correction, calibration - interchangeability                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |            |
| <b>UNIT II : PARAMETER MEASUREMENTS</b>                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     | <b>(9)</b> |
| Measurement of force, torque, power using mechanical, pneumatic, hydraulic, electrical instruments - flow measurement - rotameter, pitot tube - Temperature measurement - bimetallic strip, thermocouple, electrical resistance thermometer                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |            |
| <b>UNIT III : LINEAR AND ANGULAR MEASUREMENTS</b>                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     | <b>(9)</b> |
| Linear measuring instruments - vernier, micrometer, slip gauges, limit gauges, tool maker's microscope - interferometry, optical flats, comparators - mechanical, pneumatic, electrical applications - angular measurements - sine bar, sine center, bevel protractor, autocollimator, Angle Dekkor.                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |            |
| <b>UNIT IV : FORM MEASUREMENT</b>                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     | <b>(9)</b> |
| Fundamentals of GD & T - Measurement of Screw Thread - Measurement of Gears - Measurement of straightness, flatness and roundness - measurement of surface finish - stylus based - Tomlinson surface meter and Taylor-Hobson Talysurf - optical measurement - light cross section method - Introduction to 3D surface metrology                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |            |
| <b>UNIT V : ADVANCED METROLOGY</b>                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     | <b>(9)</b> |
| Precision instruments based on laser principles - interferometer - application in linear, angular measurements - Coordinate Measuring Machine (CMM) - constructional features - types, applications - computer aided inspection - Introduction to machine vision system - Demonstration of Modern Measurement System for Industrial Applications. |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |            |

**TEXT BOOKS:**

1. Thomas G. Beckwith, Roy D, Marangoni, John H.Lienhard V., "Mechanical Measurements", 6th ed., Pearson Education India, 2014
2. Jain R.K., "Engineering Metrology", 20th ed, Khanna Publishers, 2009

**REFERENCES:**

1. Raghavendra N.V, Krishnamurthy L, "Engineering Metrology and Measurements", 1st ed., Oxford University Press, 2013
2. R.K.Rajput A textbook of measurement and metrology ,S.K. Kataria & Sons,2013.
3. Gupta.I.C., "Engineering Metrology", 10th ed., Dhanpat Rai Publications, 2013
4. Anand K Bewoor, Vinay A Kulkarni, "Metrology & Measurement", McGraw Hill Education, 2009
5. Mahajan.M, "Engineering Metrology", Dhanapat Rai publications, 2014
6. Tayal A.K, "Instrumentation and Mechanical Measurements", 4th ed., Galgotia Publications, 2000

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |      |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|------|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |      |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2    |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    | 2    | 2    |
| 2                              |     | 2 |   |   |   |   |   |   |   |    |    | 2    |      |
| 3                              |     |   | 2 |   |   |   |   |   |   |    |    | 1    |      |
| 4                              |     |   |   |   | 2 |   |   |   |   |    |    |      | 1    |
| 5                              |     |   |   |   | 2 |   |   |   |   |    |    |      | 2    |
| CO (W.A)                       | 3   | 2 | 2 |   | 2 |   |   |   |   |    |    | 1.67 | 1.67 |

| 22MECI6 - HEAT AND MASS TRANSFER                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                        |                                                     |          |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>L</b>               | <b>T</b>                                            | <b>P</b> |
|                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>3</b>               | <b>0</b>                                            | <b>0</b> |
| <b>PREREQUISITE : NIL</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                        |                                                     |          |
| <b>Course Objective:</b>                              | <ul style="list-style-type: none"> <li>To introduce the concept of heat conduction in various systems.</li> <li>To analyze about the internal heat generation and transient heat conduction.</li> <li>To acquire knowledge on convection in various systems.</li> <li>To acquire knowledge on Boiling and Condensation, radiation heat transfer.</li> <li>To learn the basic of heat exchangers, develop the basic concept, diffusion and convective mass transfer.</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                   | Apply heat conduction principles to evaluate temperature distribution and heat transfer in walls, fins, and cylinders under steady and transient conditions.                                                                                                                                                                                                                                                                                                                   | Ap                     | 40%                                                 |          |
| CO2                                                   | Apply convection heat transfer principles and empirical correlations to determine heat transfer in forced and natural convection over flat plates and through circular pipes.                                                                                                                                                                                                                                                                                                  | Ap                     | 20%                                                 |          |
| CO3                                                   | Apply radiation laws and phase change heat transfer principles to evaluate heat transfer in radiative systems, boiling, and condensation on various surfaces.                                                                                                                                                                                                                                                                                                                  | Ap                     | 20%                                                 |          |
| CO4                                                   | Analyze the performance of heat exchangers and mass transfer systems using LMTD and NTU methods, and interpret diffusion behavior through governing equations and empirical correlations.                                                                                                                                                                                                                                                                                      | An                     | 20%                                                 |          |
| CO5                                                   | Engage in an independent study to deliver a compelling oral presentation on heat transfer modes in diverse thermal applications.                                                                                                                                                                                                                                                                                                                                               | U                      | Internal Assessment                                 |          |

|                                                                                                                                                                                                                                                                                                                                                               |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I : STEADY STATE HEAT CONDUCTION</b>                                                                                                                                                                                                                                                                                                                  | <b>(9)</b> |
| Mechanisms of heat transfer - General heat conduction equation in Cartesian coordinates –One dimensional steady state heat conduction in composite and plane walls with constant thermal conductivity - critical radius of insulation - Rectangular plate fins and pin fins with uniform cross section - Efficiency and effectiveness - circumferential fins. |            |
| <b>UNIT II - CONDUCTION WITH HEAT GENERATION</b>                                                                                                                                                                                                                                                                                                              | <b>(9)</b> |
| Solid cylinder with internal heat generation - Transient heat conduction - plane wall with negligible internal resistance - heat flow in an infinitely thick plate - chart solutions of transient heat conduction problems in plane wall.                                                                                                                     |            |
| <b>UNIT III - CONVECTION</b>                                                                                                                                                                                                                                                                                                                                  | <b>(9)</b> |
| Thermal and velocity boundary layer in flow over flat plate and flow through circular pipe - forced convection - correlations for flow over flat plate - flow across tube banks - correlations for flow through circular tubes - Natural convection in vertical and horizontal plates                                                                         |            |
| <b>UNIT IV - RADIATION, BOILING AND CONDENSATION</b>                                                                                                                                                                                                                                                                                                          | <b>(9)</b> |
| Thermal radiation - emissive power - absorption, reflection and transmission - Planck's, Wien's displacement, Stefan- Boltzmann, Kirchhoff's laws - emissivity - grey body - Radiation shields - pool boiling curve for water - boiling correlations -Nusselt's theory - condensation on vertical surfaces and horizontal tubes                               |            |



|                                                                                                                                                                                                                                                                                                              |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT V – HEAT EXCHANGERS AND MASS TRANSFER</b>                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Types of heat exchangers - overall heat transfer coefficient - fouling factors - LMTD and NTU methods - Diffusion mass transfer - Fick's law of diffusion - diffusion coefficient - equimolar counter diffusion - concentration boundary layer - governing equations - convective mass transfer correlations |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                             |            |

**TEXT BOOKS:**

1. Sachdeva.R.C, "Fundamentals of Engineering Heat and Mass transfer", 6th ed., New age international publishers, 2022.
2. Yunus A Cengel, "Heat and Mass Transfer", 6th ed., McGraw Hill Education (India) Pvt Ltd, 2020

**REFERENCES:**

1. Kothandaraman.C.P, "Fundamentals of Heat and Mass transfer", 4th ed., New age international publishers, 2012
2. Nag.P.K, "Heat and Mass Transfer", 3rd ed., McGraw Hill Education, 2011
3. Holman.J.P, "Heat Transfer", McGraw Hill Education (India) Pvt Ltd, 2017
4. Incropera and Dewitt, "Fundamentals of Heat and Mass Transfer", 7th ed., Wiley India Pvt Ltd, 2013

| Mapping of COs with POs / PSOs |          |          |   |   |   |   |   |   |          |    |    |          |   |
|--------------------------------|----------|----------|---|---|---|---|---|---|----------|----|----|----------|---|
| COs                            | POs      |          |   |   |   |   |   |   |          |    |    | PSOs     |   |
|                                | 1        | 2        | 3 | 4 | 5 | 6 | 7 | 8 | 9        | 10 | 11 | 1        | 2 |
| 1                              | 3        |          |   |   |   |   |   |   |          |    |    | 2        |   |
| 2                              | 3        |          |   |   |   |   |   |   |          |    |    | 2        |   |
| 3                              | 3        |          |   |   |   |   |   |   |          |    |    | 2        |   |
| 4                              |          | 3        |   |   |   |   |   |   |          |    |    | 2        |   |
| 5                              |          |          |   |   |   |   |   |   | 2        |    |    |          |   |
| <b>CO (W.A)</b>                | <b>3</b> | <b>3</b> |   |   |   |   |   |   | <b>2</b> |    |    | <b>2</b> |   |

| 22MECI7 - HYDRAULICS AND PNEUMATICS            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                              |          |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|----------|
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>L</b>        | <b>T</b>                                     | <b>P</b> |
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>3</b>        | <b>0</b>                                     | <b>0</b> |
| <b>PREREQUISITE :</b>                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                              |          |
| <b>Course Objective:</b>                       | <ul style="list-style-type: none"> <li>To provide the knowledge on the working principles of fluid power systems.</li> <li>To study the fluids and components used in modern industrial fluid power system.</li> <li>To develop the design, construction and operation of fluid power circuits.</li> <li>To learn the working principles of pneumatic power system and its components.</li> <li>To provide the knowledge of trouble shooting methods in fluid power systems.</li> </ul> |                 |                                              |          |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Cognitive Level | Weightage of COs in End Semester Examination |          |
| CO1                                            | Apply the concepts of fluid power in controlling actuators/components.                                                                                                                                                                                                                                                                                                                                                                                                                  | AP              | 20                                           |          |
| CO2                                            | Apply the concepts of hydraulics and pneumatics to obtain automation industrial applications.                                                                                                                                                                                                                                                                                                                                                                                           | AP              | 40                                           |          |
| CO3                                            | Analyze various fluid power circuits and select suitable actuators and control components.                                                                                                                                                                                                                                                                                                                                                                                              | AN              | 20                                           |          |
| CO4                                            | Design hydraulic and pneumatic circuits to meet the given specifications.                                                                                                                                                                                                                                                                                                                                                                                                               | AN              | 20                                           |          |
| CO5                                            | Formulate, Design, Implement, Demonstrate, Analyze a mini project relate to the course.                                                                                                                                                                                                                                                                                                                                                                                                 | AN              | Internal Assessment                          |          |

|                                                                                                                                                                                                                                                                                                                                                          |            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS</b>                                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Fluid power systems – Introduction to Fluid power – Advantages and Applications –Types of fluids - Properties of fluids – Basics of Hydraulics – Pascal’s Law – Problems, Sources of Hydraulic power: Pumping Theory – Pump Classification – Construction, Operation, Advantages, Disadvantages and Applications                                         |            |
| <b>UNIT II - HYDRAULIC ACTUATORS AND CONTROL COMPONENTS</b>                                                                                                                                                                                                                                                                                              | <b>(9)</b> |
| Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Rotary Actuators – Hydraulic motors - Control Components: Direction Control, Flow control and pressure control valves – Types, Construction, Operation and Applications – Fluid Power ANSI Symbols                                                          |            |
| <b>UNIT III - HYDRAULIC CIRCUITS AND SYSTEMS</b>                                                                                                                                                                                                                                                                                                         | <b>(9)</b> |
| Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Deceleration circuits – Applications – Mechanical, hydraulic servo systems                                                                              |            |
| <b>UNIT IV - PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS</b>                                                                                                                                                                                                                                                                                                 | <b>(9)</b> |
| Properties of air – Air preparation and distribution – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Compressors and types, Pneumatic actuators, Design of Pneumatic circuit – classification – single cylinder and multi cylinder circuits – Cascade method – Electro Pneumatic System – Elements – timer circuits |            |
| <b>UNIT V – TROUBLE SHOOTING AND APPLICATIONS</b>                                                                                                                                                                                                                                                                                                        | <b>(9)</b> |
| Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Surface grinding, Press and Forklift applications – Design of Pneumatic circuits for metal working, handling, clamping counter and timer circuits – IoT in Hydraulics and pneumatics                  |            |

**TEXT BOOKS:**

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. James A. Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 1997

**REFERENCES:**

1. Jagadeesha. T., "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.
2. Joshi.P., "Pneumatic Control", Wiley India, 2008.
3. Majumdar, S.R., "Oil Hydraulics Systems – Principles and Maintenance", TataMcGraw Hill, 2001.
4. Shanmugasundaram.K., "Hydraulic and Pneumatic Controls". Chand & Co, 2006.
5. Srinivasan.R., "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 3rd edition, 2019.

| Mapping of COs with POs / PSOs |          |          |            |   |   |   |   |          |          |          |          |          |          |
|--------------------------------|----------|----------|------------|---|---|---|---|----------|----------|----------|----------|----------|----------|
| CO                             | POs      |          |            |   |   |   |   |          |          |          |          | PSOs     |          |
|                                | 1        | 2        | 3          | 4 | 5 | 6 | 7 | 8        | 9        | 10       | 11       | 1        | 2        |
| 1                              | 3        |          |            |   |   |   |   |          |          |          |          | 3        |          |
| 2                              | 3        |          |            |   |   |   |   |          |          |          |          | 3        |          |
| 3                              |          | 3        |            |   |   |   |   |          |          |          |          | 3        |          |
| 4                              |          |          | 3          |   |   |   |   |          |          |          |          | 3        |          |
| 5                              |          |          | 2          |   |   |   |   | 2        | 1        | 1        | 1        | 3        | 2        |
| <b>CO<br/>(W.A)</b>            | <b>3</b> | <b>3</b> | <b>2.5</b> |   |   |   |   | <b>2</b> | <b>1</b> | <b>1</b> | <b>1</b> | <b>3</b> | <b>2</b> |

| 22MEP05 - HEAT AND MASS TRANSFER LABORATORY    |                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                     |   |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---------------------|---|
|                                                |                                                                                                                                                                       | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | T | P                   | C |
|                                                |                                                                                                                                                                       | 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0 | 4                   | 2 |
| PREREQUISITE :                                 |                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                     |   |
| Course Objective:                              |                                                                                                                                                                       | <ul style="list-style-type: none"><li>• To calculate the thermal conductivity of different materials.</li><li>• To analyze the efficiency of fin.</li><li>• To acquire knowledge on natural convection from a vertical cylinder and forced convection inside tube.</li><li>• To identify the value of Stefan - Boltzmann constant and emissivity of a grey body.</li><li>• To learn the basics of parallel and counter flow heat exchangers and to acquire knowledge on Boiling and Condensation.</li></ul> |   |                     |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   | Cognitive Level     |   |
| CO1                                            | Apply experimental methods to determine the thermal conductivity of solid and insulating materials using guarded plate, lagged pipe, and insulating powder apparatus. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   | Ap                  |   |
| CO2                                            | Analyze natural and forced convection heat transfer by evaluating heat transfer coefficients from vertical cylinders and internal pipe flows.                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   | An                  |   |
| CO3                                            | Determine radiation characteristics by evaluating the emissivity of surfaces and verifying Stefan-Boltzmann law using standard experimental setups.                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   | An                  |   |
| CO4                                            | Evaluate fin efficiency, heat exchanger effectiveness, and heat transfer in boiling and condensation processes through practical measurements.                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   | E                   |   |
| CO5                                            | Conduct an independent study to analyze and interpret the behavior of different heat transfer mechanisms in thermal systems.                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   | Internal Assessment |   |

| LIST OF EXPERIMENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <ol style="list-style-type: none"> <li>Thermal conductivity measurement using guarded plate apparatus</li> <li>Thermal conductivity measurement of pipe insulation using lagged pipe apparatus</li> <li>Efficiency calculation of a pin-fin apparatus</li> <li>Determination of heat transfer coefficient under natural convection from a vertical cylinder</li> <li>Determination of heat transfer coefficient by forced convection inside tube</li> <li>Determination of Stefan - Boltzmann constant</li> <li>Determination of emissivity of a given grey surface</li> <li>Determine the effectiveness of parallel / counter flow heat exchanger</li> <li>Determination of heat flux in boiling and condensation heat transfer</li> <li>Determination of thermal conductivity of insulating powder</li> </ol> |  |
| <b>TOTAL (P:60) = 60 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
| <b>REFERENCES:</b> <ol style="list-style-type: none"> <li>Sachdeva.R.C, "Fundamentals of Engineering Heat and Mass transfer", 6th ed., New age international publishers, 2024.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |

| Mapping of COs with POs / PSOs |          |          |   |   |   |   |   |          |   |    |    |          |   |
|--------------------------------|----------|----------|---|---|---|---|---|----------|---|----|----|----------|---|
| COs                            | POs      |          |   |   |   |   |   |          |   |    |    | PSOs     |   |
|                                | 1        | 2        | 3 | 4 | 5 | 6 | 7 | 8        | 9 | 10 | 11 | 1        | 2 |
| 1                              | 3        |          |   |   |   |   |   |          |   |    |    | 2        |   |
| 2                              |          | 3        |   |   |   |   |   |          |   |    |    | 2        |   |
| 3                              |          | 3        |   |   |   |   |   |          |   |    |    | 2        |   |
| 4                              |          | 3        |   |   |   |   |   |          |   |    |    | 2        |   |
| 5                              |          |          |   |   |   |   |   | 2        |   |    |    |          |   |
| <b>CO<br/>(W.A)</b>            | <b>3</b> | <b>3</b> |   |   |   |   |   | <b>2</b> |   |    |    | <b>2</b> |   |



| 22MEP06 - METROLOGY AND MEASUREMENTS LABORATORY |                                                                                                                                                                                                                                                                                                                                                                           |                 |   |   |
|-------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---|
|                                                 | L                                                                                                                                                                                                                                                                                                                                                                         | T               | P | C |
|                                                 | 0                                                                                                                                                                                                                                                                                                                                                                         | 0               | 4 | 2 |
| PREREQUISITE : NIL                              |                                                                                                                                                                                                                                                                                                                                                                           |                 |   |   |
| Course Objective:                               | <ul style="list-style-type: none"><li>• To measure the linear dimensions of the components.</li><li>• To identify the various gear teeth parameters.</li><li>• To measure the angular dimensions of the components</li><li>• To measure the straightness, flatness of the surface</li><li>• To acquire knowledge on measurement parameters and its applications</li></ul> |                 |   |   |
| Course Outcomes<br>The Student will be able to  |                                                                                                                                                                                                                                                                                                                                                                           | Cognitive Level |   |   |
| CO1                                             | Calibrate the measuring instruments and measure the dimension of the components                                                                                                                                                                                                                                                                                           | Ap              |   |   |
| CO2                                             | Select proper instruments for measurement                                                                                                                                                                                                                                                                                                                                 | Ap              |   |   |
| CO3                                             | Calculate least count of instrument, take reading using the instrument.                                                                                                                                                                                                                                                                                                   | Ap              |   |   |
| CO4                                             | Determine the characteristics of instruments.                                                                                                                                                                                                                                                                                                                             | An              |   |   |
| CO5                                             | Identify the surface finish of a component.                                                                                                                                                                                                                                                                                                                               | An              |   |   |

| <b>List of Experiments</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <ol style="list-style-type: none"> <li>Determination of Linear dimensions of a part using Vernier Caliper / Micrometer.</li> <li>Determination of Linear dimensions of a part using Vernier Height Gauge and Vernier depth gauge.</li> <li>Measurement of Internal Bore diameter using Digital Bore Gauge.</li> <li>Measurement of Gear Tooth Dimensions using Gear Tooth vernier.</li> <li>Measurement of Taper Angle using Bevel Protractor / Sine bar / Slip Gauges.</li> <li>Measurement of given Component using Profile Projector.</li> <li>Measurement of screw thread parameters using Tool Makers Microscope.</li> <li>Measurement of straightness and flatness of surface plate using Autocollimator.</li> <li>Measurement Surface Finish using surface roughness tester.</li> <li>Measurement of Force /torque.</li> <li>Measurement of Temperature using thermo couples.</li> <li>Measurement of displacement using LVDT.</li> </ol> |  |
| <b>TOTAL (P:60) = 60 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |      |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|------|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |      |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2    |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    | 2    | 2    |
| 2                              |     | 2 |   |   |   |   |   |   |   |    |    | 2    | 1    |
| 3                              |     |   | 2 |   |   |   |   |   |   |    |    | 1    |      |
| 4                              |     |   |   |   | 2 |   |   |   |   |    |    | 1    | 2    |
| 5                              |     |   |   |   |   |   |   |   | 2 |    |    |      |      |
| CO<br>(W.A)                    | 3   | 2 | 2 |   | 2 |   |   |   | 2 |    |    | 1.5  | 1.67 |



| 22MAN08R - SOFT/ANALYTICAL SKILLS – IV<br>(Common to All Branches) |                                                                                                                                                                                                              |                        |                                                       |          |
|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-------------------------------------------------------|----------|
|                                                                    |                                                                                                                                                                                                              | <b>L</b>               | <b>T</b>                                              | <b>P</b> |
|                                                                    |                                                                                                                                                                                                              | <b>1</b>               | <b>0</b>                                              | <b>2</b> |
| <b>PREREQUISITE : 22MAN07R</b>                                     |                                                                                                                                                                                                              |                        |                                                       |          |
| <b>Course Objective:</b>                                           | <ul style="list-style-type: none"> <li>To enhance the ability to communicate coherently and effectively across contexts</li> <li>To develop quantitative aptitude and analytical reasoning skills</li> </ul> |                        |                                                       |          |
| <b>Course Outcomes</b><br>The Student will be able to              |                                                                                                                                                                                                              | <b>Cognitive Level</b> | <b>Weightage of COs in Continuous Assessment Test</b> |          |
| CO1                                                                | Develop proficiency to communicate accurately, fluently, and appropriately in various academic, professional and social contexts.                                                                            | U                      | 40%                                                   |          |
| CO2                                                                | Solve quantitative aptitude problems with more confidence.                                                                                                                                                   | Ap                     | 30%                                                   |          |
| CO3                                                                | Draw valid conclusions, identify patterns, and solve problems.                                                                                                                                               | An                     | 30%                                                   |          |

|                                                                                                                                                                                                                                              |             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| <b>UNIT I – VERBAL ABILITY</b>                                                                                                                                                                                                               | <b>(15)</b> |
| Grammar - Sentence Completion – Sentence Improvement - Error Spotting - <b>Listening</b> - TOEFL Listening Practice Tests - <b>Speaking</b> – Interview Skills - <b>Reading</b> - GRE Reading Passages - <b>Writing</b> - Paragraph Writing. |             |
| <b>UNIT II – APTITUDE</b>                                                                                                                                                                                                                    | <b>(15)</b> |
| Probability - Permutations and Combinations - Data Interpretation on Multiple Charts - Mensuration - Area, Shapes, Perimeter - Races and Games.                                                                                              |             |
| <b>UNIT III - REASONING</b>                                                                                                                                                                                                                  | <b>(15)</b> |
| Data Sufficiency - Mathematical Operations - Pattern Completion - Cubes - Embedded Images.                                                                                                                                                   |             |
| <b>TOTAL(L:45) = 45 PERIODS</b>                                                                                                                                                                                                              |             |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 1. Rizvi, M.Ashraf. <i>Effective Technical Communication</i> . Tata McGraw-Hill Education, 2017.<br>2. Aggarwal R S. <i>Quantitative Aptitude for Competitive Examinations</i> . S.Chand Publishing Company Ltd(s)., 2022.<br>3. Sharma, Arun. <i>How to Prepare for Quantitative Aptitude for the CAT</i> . Tata McGraw – Hill Publishing, 2022.<br>4. Praveen R V. <i>Quantitative Aptitude and Reasoning</i> . PHI Learning Pvt. Ltd., 2016. |



| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              |     |   |   |   |   |   | 2 | 3 |   |    |    |      |   |
| 2                              |     | 2 |   | 2 |   |   |   |   |   |    |    |      |   |
| 3                              |     | 2 |   | 2 |   |   |   |   |   |    |    |      |   |
| <b>CO</b><br>(W.A)             |     | 2 |   | 2 |   |   | 2 | 3 |   |    |    |      |   |

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| 22MECI18 – FINITE ELEMENT ANALYSIS             |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                 |   |   |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|---|---|
|                                                |                                                                                                        | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | T                               | P | C |
|                                                |                                                                                                        | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0                               | 0 | 3 |
| PRE REQUISITE : NIL                            |                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                 |   |   |
| Course Objectives:                             |                                                                                                        | <ul style="list-style-type: none"><li>To introduce the concepts of Mathematical Modeling and numerical solution of engineering problems</li><li>To appreciate the use of Finite Element Method to a range of engineering problems</li><li>To gain knowledge related to two dimensional scalar variable problems with heat transfer</li><li>To introduce the vector variable of the axisymmetric problems and fluid mechanics</li><li>To teach Isoparametric formulation and advanced topics in FEM</li></ul> |                                 |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                        | Cognitive level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Weightage in End Semester exams |   |   |
| CO1                                            | Apply the finite element theory and procedures to various structural and non-structural applications   | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 20%                             |   |   |
| CO2                                            | Calculate the stiffness matrices and stress values in 1D and 2D elements using finite element concepts | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 20%                             |   |   |
| CO3                                            | Analyze the three dimensional elements using axisymmetric concepts                                     | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 20%                             |   |   |
| CO4                                            | Estimate the stiffness matrices of isoparametric elements using FEM methods                            | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 20%                             |   |   |
| CO5                                            | Perform the dynamic analysis of elements using FEM method                                              | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 20%                             |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - BASIC CONCEPTS AND 1D ELEMENTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>(9)</b> |
| Basic concepts - types of analysis - general procedure for FEA - introduction to meshing - discretization - weak form - governing equations – discrete and continuous models - boundary, initial and eigen value problems - weighted residual method - Ritz method- applications - finite element modeling - coordinates - shape functions - stiffness matrix and assembly - boundary conditions - solution of equations - mechanical loads, stresses and thermal effects - bar and beam elements - one-dimensional heat transfer problems |            |
| <b>UNIT II - 2D ELEMENTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Finite element modeling - Poisson equation - Laplace equation - plane stress, plane strain - CST element - element equations, load vectors and boundary conditions - truss - deflection - stresses - Pascal's triangles - assembly - application in two dimensional heat transfer problems                                                                                                                                                                                                                                                 |            |
| <b>UNIT III - AXISYMMETRIC PROBLEMS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Vector variable problems - elasticity equations - axisymmetric problems - formulation - element matrices - assembly - boundary conditions and solutions - introduction to plates and shells                                                                                                                                                                                                                                                                                                                                                |            |
| <b>UNIT IV - ISOPARAMETRIC ELEMENTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Isoparametric elements - four node quadrilateral element - shape functions - Jacobian matrix - element stiffness matrix and force vector - serendipity elements - numerical integration - stiffness integration - displacement and stress calculations                                                                                                                                                                                                                                                                                     |            |
| <b>UNIT V – DYNAMIC ANALYSIS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <b>(9)</b> |
| Types of dynamic analysis - general dynamic equation of motion, point and distributed mass - lumped and consistent mass - mass matrices formulation of bar and beam element - undamped - free vibration - eigen value and eigen vectors problems                                                                                                                                                                                                                                                                                           |            |

|                                                                                                    |
|----------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS</b>                                                                                  |
| 1. S.S. Rao, “The Finite Element Method in Engineering”, 6th Edition, Butterworth-Heinemann, 2018. |
| 2. J.N. Reddy, “Introduction to the Finite Element Method”, 4th Edition, Tata McGrawHill, 2018.    |

**REFERENCES:**

1. K. Tirupathi, Chandrupatla and D. Ashok Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.
2. David Hutton, "Fundamentals of Finite Element Analysis", Tata McGrawHill, 2005
3. R. Dhanaraj and K. Prabhakaran Nair, "Finite Element Analysis", Oxford Publications, 2015.
4. D. Robert Cook, S. David Malkus, E. Michael Plesha, J. Robert Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2004.
5. P. Seshu, "Text Book of Finite Element Analysis", PHI Learning Pvt. Ltd., NewDelhi, 2012.

| Mapping of COs with POs / PSOs |          |          |            |          |          |          |   |          |          |    |          |          |   |
|--------------------------------|----------|----------|------------|----------|----------|----------|---|----------|----------|----|----------|----------|---|
| COs                            | POs      |          |            |          |          |          |   |          |          |    |          | PSOs     |   |
|                                | 1        | 2        | 3          | 4        | 5        | 6        | 7 | 8        | 9        | 10 | 11       | 1        | 2 |
| 1                              | 3        |          |            |          |          |          |   |          |          |    |          | 3        |   |
| 2                              | 3        |          |            | 2        | 1        |          |   |          |          |    |          | 3        |   |
| 3                              |          | 3        | 1          |          |          |          |   |          |          |    |          | 3        |   |
| 4                              |          | 3        | 2          | 2        | 1        |          |   |          |          |    |          | 3        |   |
| 5                              |          |          | 2          |          |          | 1        |   | 1        | 2        |    | 2        | 3        |   |
| <b>CO<br/>(W.A)</b>            | <b>3</b> | <b>3</b> | <b>1.6</b> | <b>2</b> | <b>1</b> | <b>1</b> |   | <b>1</b> | <b>2</b> |    | <b>2</b> | <b>3</b> |   |

| 22MECI9 - MECHATRONICS AND IoT                 |                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                              |   |   |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                                                        | L                                                                                                                                                                                                                                                                                                                                                                                                                                                            | T                                            | P | C |
|                                                |                                                                                                                                                                        | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0                                            | 0 | 3 |
| PREREQUISITE : 22MECI7                         |                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                              |   |   |
| Course Objective:                              |                                                                                                                                                                        | <ul style="list-style-type: none"><li>• To make students get acquainted with the sensors and the actuators in mechatronics systems</li><li>• To provide insight into the control systems in Mechatronics</li><li>• To understand the concepts and programming in PLC</li><li>• To make students familiarize with the fundamentals of IoT systems</li><li>• To inculcate skills in the design and development of Mechatronics and IoT based systems</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                        | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                              | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply the concept of sensors and actuator for Mechatronics application                                                                                                 | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 20%                                          |   |   |
| CO2                                            | Analyze the output response of various control modes of systems                                                                                                        | An                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 20%                                          |   |   |
| CO3                                            | Investigate and analyze the operations of microcontroller and PLC for mechatronics applications                                                                        | An                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 20%                                          |   |   |
| CO4                                            | Interfacing the IoT concepts in the Mechatronics systems                                                                                                               | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 40%                                          |   |   |
| CO5                                            | Engage in an independent study as a member of a team or individual and investigate, design, develop a mini-project demonstrating the Mechatronics and IoT applications | C                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |            |
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| <b>UNIT I - SENSORS AND ACTUATORS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Introduction to Mechatronics - emerging areas of Mechatronics - sensors and transducers - static and dynamic characteristics, transducers - resistive, capacitive, and inductive, optical sensors - photodetectors - vision systems - laser - fibre optic - non-fibre optic, solid state sensors, piezoelectric and ultrasonic sensors - humidity sensor - temperature sensors - actuators - brushless permanent magnet DC motor - PM, VR and hybrid stepper motors - DC and AC servo motors                             |            |
| <b>UNIT II - CONTROL SYSTEMS, MICROPROCESSOR AND MICROCONTROLLER</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>(9)</b> |
| Control systems - open and closed loop systems - automatic control of water level - analogue and digital control systems - control modes - two step, proportional, derivative, integral and PID controllers - microprocessor - architecture of 8085 microprocessor - pin configuration - architecture of 8051 microcontroller - single-chip microcontroller systems - single-board microcontroller systems - single-board computer systems - embedded systems - peripherals - typical architecture of a CAN based system |            |
| <b>UNIT III - PROGRAMMABLE LOGIC CONTROLLER</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>(9)</b> |
| Programmable logic controller - architecture - input / output processing - ladder diagrams - latching, sequencing, timers, counters and internal relays - data handling - selection of PLC - application of PLCs for control                                                                                                                                                                                                                                                                                             |            |
| <b>UNIT IV - FUNDAMENTALS OF IoT AND CONTROLLERS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>(9)</b> |
| The Internet of Things ( IoT) - introduction to the IoT framework - IoT enabling technologies - the effective implementation of IoT - foundation topics: C Programming - Arduino: the Arduino Boards - Arduino peripherals- Arduino IDE - ESP series Wi-Fi module - (typical peripherals) interfacing and controlling I/O devices by Arduino : LEDs - sensor and actuator interactions                                                                                                                                   |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |
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| <b>UNIT V – MECHATRONICS AND IoT CASE STUDIES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Mechatronics systems: Drone actuation and Control -Autonomous Robot with Vision System, Automotive Mechatronics: Electronic Ignition System - ABS - EBD - Adaptive Cruise Control. IoT case studies: Remote Monitoring Systems- Remotely Operated Autonomous Systems - Centralized Water Management System - IoT sensors for climate control - IoT Enabled Robotic Camera Dolly - Portable, Wireless, Interactive IoT Sensors for Agriculture - IoT Vehicle Management System with Network Selection |            |

### TEXT BOOKS

1. D.A. Bradley, N.C. Burd, D. Dawson, A.J. Loader, "Mechatronics: Electronics in Products and Processes", Routledge, 2017.
2. S.H. Sami and G. Kisheen Rao, "The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers", CRC Press, 2022.

### REFERENCES:

1. John Billingsley, "Essentials of Mechatronics", Wiley, 2006.
2. Willia Bolton, "Mechatronics: Electronic Control Systems In Mechanical and Electrical Engineering", 7<sup>th</sup> ed., Pearson Education, Pearson India, 2023.
3. Bolton. W, "Mechatronics - A Multidisciplinary Approach", 4th ed., Pearson Education India, 201
4. David H., Gonzalo S., Patrick G., Rob B. and Jerome H., "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Pearson Education, 2018
5. Nitin G and Sharad S, "Internet of Things: Robotic and Drone Technology", CRC Press, 2022

| Mapping of COs with POs / PSOs |          |          |          |          |            |   |   |          |          |          |          |          |          |
|--------------------------------|----------|----------|----------|----------|------------|---|---|----------|----------|----------|----------|----------|----------|
| COs                            | POs      |          |          |          |            |   |   |          |          |          |          | PSOs     |          |
|                                | 1        | 2        | 3        | 4        | 5          | 6 | 7 | 8        | 9        | 10       | 11       | 1        | 2        |
| 1                              | 3        |          |          |          |            |   |   |          |          |          |          | 3        | 2        |
| 2                              |          | 3        |          |          |            |   |   |          |          |          |          | 3        | 2        |
| 3                              |          | 3        |          | 2        | 2          |   |   |          |          |          |          | 3        | 2        |
| 4                              | 3        |          |          |          | 3          |   |   |          |          |          |          | 3        | 2        |
| 5                              |          |          | 3        | 2        | 3          |   |   | 1        | 1        | 2        | 1        | 3        | 2        |
| <b>CO (W. A)</b>               | <b>3</b> | <b>3</b> | <b>3</b> | <b>2</b> | <b>2.6</b> |   |   | <b>1</b> | <b>1</b> | <b>2</b> | <b>1</b> | <b>3</b> | <b>2</b> |

| 22MEP07 - COMPUTER AIDED ANALYSIS LABORATORY   |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                 |   |   |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------|---|---|
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 | L | T               | P | C |
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0 | 0               | 4 | 2 |
| PREREQUISITE :                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                 |   |   |
| Course Objective:                              | <ul style="list-style-type: none"><li>• To acquire skill in finite element simulations using software</li><li>• To know the steps involved in discretization of the CAD model using various elements</li><li>• To teach the steps involved in solving structural problems with given specifications</li><li>• To gain knowledge on modal and harmonic analysis</li><li>• To understand the thermal analysis with given specifications</li></ul> |   |                 |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   | Cognitive Level |   |   |
| CO1                                            | Apply FEM methods for solving structural analysis problems using software                                                                                                                                                                                                                                                                                                                                                                       |   | Ap              |   |   |
| CO2                                            | Analyze static and axi-symmetric elements under given boundary conditions using FEA software                                                                                                                                                                                                                                                                                                                                                    |   | An              |   |   |
| CO3                                            | Design a structural component and perform (simulate) modal analysis using FEA software                                                                                                                                                                                                                                                                                                                                                          |   | An              |   |   |
| CO4                                            | Conduct experiments to evaluate the Harmonic response of a structural system using simulation                                                                                                                                                                                                                                                                                                                                                   |   | An              |   |   |
| CO5                                            | Use the tool ANSYS to interpret the simulation results for engineering heat transfer applications                                                                                                                                                                                                                                                                                                                                               |   | An              |   |   |

| LIST OF EXPERIMENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none"> <li>1. Analysis of a plate with a circular hole.</li> <li>2. Analysis of bar (Straight, Stepped, Taper bar).</li> <li>3. Analysis of beams (Cantilever, Simply supported, Fixed ends).</li> <li>4. Analysis of truss component.</li> <li>5. Analysis of an Axi-symmetric component.</li> <li>6. Modal analysis of a component.</li> <li>7. Harmonic analysis of a component.</li> <li>8. Thermal analysis of the components (Fin and Wall).</li> <li>9. Thermal mixed boundary conditions (Conduction and Convection).</li> <li>10. Contact analysis experiment of beam</li> <li>11. Application of plane stress and plane strain conditions</li> <li>12. Modelling and analysis of tapered structures</li> </ol> |
| <b>TOTAL (P:60) = 60 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

| Mapping of COs with POs / PSOs |          |          |          |          |          |   |   |   |          |    |          |          |          |
|--------------------------------|----------|----------|----------|----------|----------|---|---|---|----------|----|----------|----------|----------|
| COs                            | POs      |          |          |          |          |   |   |   |          |    |          | PSOs     |          |
|                                | 1        | 2        | 3        | 4        | 5        | 6 | 7 | 8 | 9        | 10 | 11       | 1        | 2        |
| 1                              | 3        |          |          |          | 3        |   |   |   | 2        |    | 2        | 1        | 3        |
| 2                              |          | 3        |          |          | 3        |   |   |   | 2        |    | 2        | 1        | 3        |
| 3                              |          |          | 3        |          | 3        |   |   |   | 2        |    | 2        | 1        | 3        |
| 4                              |          |          |          | 3        | 3        |   |   |   | 2        |    | 2        | 1        | 3        |
| 5                              |          |          |          |          | 3        |   |   |   | 2        |    | 2        | 1        | 3        |
| <b>CO<br/>(W.A)</b>            | <b>3</b> | <b>3</b> | <b>3</b> | <b>3</b> | <b>3</b> |   |   |   | <b>2</b> |    | <b>2</b> | <b>1</b> | <b>3</b> |



| 22MEP08 - MECHATRONICS AND IoT LABORATORY |   |   |   |   |
|-------------------------------------------|---|---|---|---|
|                                           | L | T | P | C |
|                                           | 0 | 0 | 4 | 2 |

**PRE REQUISITE : 22MEC17**

| <b>Course Objective:</b>                              |                                                                                                                                               | <ul style="list-style-type: none"> <li>To introduce the integrated approach of Mechatronics systems</li> <li>To design, model and analyze the electrical, hydraulic and pneumatic systems with mechatronics perspective</li> <li>To understand the concepts of computerized data logging system</li> <li>To stimulate interfacing techniques between electromechanical and microcontrollers</li> <li>To know the fundamentals of IoT and IoT boards</li> </ul> |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Course Outcomes</b><br>The Student will be able to |                                                                                                                                               | <b>Cognitive Level</b>                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| CO1                                                   | Apply the concept of fluid power systems to activate the cylinders                                                                            | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| CO2                                                   | Simulate the cylinder sequencing using the software tool                                                                                      | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| CO3                                                   | Analyze the system automation by interfacing with microcontroller and PLC                                                                     | An                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| CO4                                                   | Conduct experiments and analyze the functioning / performance of the control system by using computerized data logging in Mechatronics system | An                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| CO5                                                   | Engage in independent study and design and develop a program to automate the Mechatronics elements using IoT                                  | C                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

**LIST OF EXPERIMENTS**

1. Manual Control of single and double acting cylinders with direction control valves using pneumatic trainer kit
2. Simulation of cylinder sequencing using hydraulic control by Cascade method
3. Pneumatic cylinder sequencing using electrical control with Internal Relay
4. Process control using PID controller
5. Control of double acting cylinder using Timer, DPDT relay with solenoid operated valves
6. Stepper motor interfacing using 8051 microcontroller
7. Process control of Automatic bottle filling system using PLC
8. Computerized data logging system for process control variables like level and temperature
9. To interface LED/Buzzer with Arduino/ Raspberry Pi and write a program to turn ON LED for a given time period at a given frequency
10. Experiment on monitoring Machinery Vibration Using Vibration Sensors and programming tool

**TOTAL (P:60) = 60 PERIODS**



| Mapping of COs with POs / PSOs |          |            |          |            |          |          |   |          |   |    |          |          |          |
|--------------------------------|----------|------------|----------|------------|----------|----------|---|----------|---|----|----------|----------|----------|
| COs                            | POs      |            |          |            |          |          |   |          |   |    |          | PSOs     |          |
|                                | 1        | 2          | 3        | 4          | 5        | 6        | 7 | 8        | 9 | 10 | 11       | 1        | 2        |
| 1                              | 3        |            | 2        |            |          |          |   |          |   |    |          | 3        | 3        |
| 2                              | 3        | 3          |          |            | 2        |          |   |          |   |    |          | 3        | 3        |
| 3                              |          | 3          | 2        |            | 2        |          |   |          |   |    |          | 3        | 3        |
| 4                              |          | 2          |          | 2          | 2        |          |   |          |   |    |          | 3        | 3        |
| 5                              |          |            | 2        | 1          | 2        | 1        |   | 1        |   |    | 2        | 3        | 3        |
| <b>CO<br/>(W.<br/>A)</b>       | <b>3</b> | <b>2.7</b> | <b>2</b> | <b>1.5</b> | <b>2</b> | <b>1</b> |   | <b>1</b> |   |    | <b>1</b> | <b>3</b> | <b>3</b> |



| 22MEC20 - CAD/CAM/CIM                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              |   |   |
|--------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | L               | T                                            | P | C |
|                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : Engineering drawing, Material removal process |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              |   |   |
| Course Objective:                                            | <ul style="list-style-type: none"><li>To understand the CAD implementation, design process models, benefits of CAD, hardware components, and fundamental geometric modeling techniques including wireframe, surface, and solid modeling.</li><li>To understand the standards and principles of computer graphics, including various graphic exchange formats, communication standards, coordinate systems, transformations, and clipping techniques.</li><li>To explore the functions, benefits, and techniques of Computer-Aided Manufacturing (CAM), including process planning, part classification, coding systems, and engineering approaches like sequential and concurrent engineering.</li><li>To understand the principles, components, and programming of CNC machine tools, including various types of machine tools, functions, and part programming techniques.</li><li>To learn the components and systems of Computer-Integrated Manufacturing (CIM), including Flexible Manufacturing Systems (FMS), production planning techniques, and shop floor control.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                                          | Apply geometric modeling techniques and CAD implementation concepts to design processes using various modeling approaches and hardware interfaces.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Ap              | 20%                                          |   |   |
| CO2                                                          | Apply CAD standards and computer graphics principles for effective data exchange, transformations, and visualization in engineering design.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Ap              | 20%                                          |   |   |
| CO3                                                          | Analyze and apply computer-aided manufacturing and computer-integrated manufacturing techniques, including process planning, coding systems, and production planning, to optimize product development, resource utilization, and shop floor control.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | An              | 40%                                          |   |   |
| CO4                                                          | Utilize CNC machine tools and programming techniques to enhance precision manufacturing and automation in engineering applications.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Ap              | 20%                                          |   |   |
| CO5                                                          | Engage in independent study as a member of a team or individual and make effective oral presentation on CAM & CIM systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Ap              | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                  |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I : GEOMETRIC MODELLING TECHNIQUES</b>                                                                                                                                                                                                                                                                                                   | <b>(9)</b> |
| CAD implementation - design Process - Shigley, Pahl and Beitz, Ohsuga, Earle model - benefits of CAD - hardware - input and output devices - display devices - LCD, LED - geometric modeling - basics of wire frame, surface, solid modeling                                                                                                     |            |
| <b>UNIT II : CAD STANDARDS &amp; PRINCIPLES OF COMPUTER GRAPHICS</b>                                                                                                                                                                                                                                                                             | <b>(9)</b> |
| Types of standards-Graphics and Exchange standards-IGES-DXF-Standard for exchange of product model data Communication standards LAN, WAN - transformation in graphics - coordinate system used in graphics and windowing - viewport - 2D Transformation - homogeneous transformation - combination transformation - clipping - 3D transformation |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT III : COMPUTED AIDED MANUFACTURING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>(9)</b> |
| Function of CAM - benefits of CAM - Group Technology - Part families - Production flow analysis - Parts classification and coding - OPITZ, MI CLASS and DCLASS coding systems - computed aided process planning - retrieval type CAPP, generative CAPP - product development cycle - sequential engineering - concurrent engineering                                                                                                                                                                                                                                                 |            |
| <b>UNIT IV : CNC MACHINE TOOLS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>(9)</b> |
| Principle of numerical control - component of NC system - NC procedure - types of CNC machine tools - programming of CNC machine tools - preparatory functions - miscellaneous functions - part programming - types - turning and machining center                                                                                                                                                                                                                                                                                                                                   |            |
| <b>UNIT V : COMPUTER INTEGRATED MANUFACTURING AND PRODUCTION PLANNING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Flexible Manufacturing System (FMS)-Components - Manufacturing systems-Material handling systems - Tool handling - Layouts of FMS - development of CIM - material requirement planning - capacity requirement planning - manufacturing resource planning - just in time - shop floor control.                                                                                                                                                                                                                                                                                        |            |
| <b>TOTAL (L:45) : 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |
| <b>TEXT BOOKS :</b><br>1. Ibrahim Zeid and Sivasubramanian, R, "CAD/CAM Theory and Practice", Tata McGraw Hill Publications, New Delhi, 2009<br>2. Radhakrishnan.P, Subramanyan.S, Raju.V, "CAD/CAM/CIM", 4th ed., New Age International Publishers Ltd., 20                                                                                                                                                                                                                                                                                                                         |            |
| <b>REFERENCES:</b><br>1. Chris McMohan and Jimmie Browne, "CAD/CAM Principles, Practice and Manufacturing Management", 2nd ed., Pearson Education (Singapore) Pvt. Ltd., 2000<br>2. David F. Rogers, J. A. Adams, "Mathematical Elements for Computer Graphics", Tata McGraw Hill Publications, 2017<br>3. Donald Hearn and M. Pauline Baker, "Computer Graphics" Eastern Economy Edition, 2007<br>4. Groover, M. P. and Zimmers, E. W., "CAD/ CAM", Dorling Kingsley, 2008<br>5. Mikell P. Groover and Zimmers.W, "CAD/CAM - Computer Aided and Manufacturing", Pearson India, 2008 |            |

| Mapping of COs with POs / PSOs |          |          |   |   |          |   |   |          |          |    |    |          |   |
|--------------------------------|----------|----------|---|---|----------|---|---|----------|----------|----|----|----------|---|
| COs                            | POs      |          |   |   |          |   |   |          |          |    |    | PSOs     |   |
|                                | 1        | 2        | 3 | 4 | 5        | 6 | 7 | 8        | 9        | 10 | 11 | 1        | 2 |
| 1                              | 3        |          |   |   |          |   |   |          |          |    |    | 3        |   |
| 2                              | 3        |          |   |   |          |   |   |          |          |    |    | 3        |   |
| 3                              |          | 3        |   |   |          |   |   |          |          |    |    | 3        |   |
| 4                              |          |          |   |   | 3        |   |   |          |          |    |    | 3        |   |
| 5                              | 3        |          |   |   |          |   |   | 3        | 3        |    |    | 3        |   |
| <b>CO (W.A)</b>                | <b>3</b> | <b>3</b> |   |   | <b>3</b> |   |   | <b>3</b> | <b>3</b> |    |    | <b>3</b> |   |



| 22GEA01 - UNIVERSAL HUMAN VALUES<br>(Common To All Branches) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |   |                                                 |
|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|-------------------------------------------------|
|                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | L               | T | P                                               |
|                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 2               | 0 | 0                                               |
| PREREQUISITE : NIL                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |   |                                                 |
| <b>Course Objective:</b>                                     | <ul style="list-style-type: none"> <li>To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity.</li> <li>To facilitate the development of a holistic perspective among students towards life and profession.</li> <li>To highlight plausible implications of holistic understanding in terms of ethical human conduct.</li> <li>To understand the nature and existence.</li> <li>To understand human contact and holistic way of living</li> </ul> |                 |   |                                                 |
| Course Outcomes<br>The Student will be able to               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Cognitive Level |   | Weightage of COs<br>in End Semester Examination |
| CO1                                                          | Construct a framework that incorporates value inputs into formal education and execute strategies to implement these values in their daily life and career decisions.                                                                                                                                                                                                                                                                                                                                                               | Ap              |   | 20%                                             |
| CO2                                                          | Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual.                                                                                                                                                                                                                                                                                                                                                                         | Ap              |   | 20%                                             |
| CO3                                                          | Analyze the value of harmonious relationship based on trust and respect in their life and profession.                                                                                                                                                                                                                                                                                                                                                                                                                               | Ap              |   | 20%                                             |
| CO4                                                          | Examine the role of a human being in ensuring harmony in society and nature.                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Ap              |   | 20%                                             |
| CO5                                                          | Apply the understanding of ethical conduct to formulate the strategy for ethical life and profession.                                                                                                                                                                                                                                                                                                                                                                                                                               | Ap              |   | 20%                                             |

|                                                                                                                                                                                                                                                                                                                       |     |
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| <b>UNIT I - INTRODUCTION-BASIC HUMAN ASPIRATION, ITS FULFILLMENT THROUGH ALL- ENCOMPASSING RESOLUTION</b>                                                                                                                                                                                                             | (6) |
| The basic human aspirations and their fulfillment through Right understanding and Resolution, Right understanding and Resolution as the activities of the Self, Self being central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution |     |
| <b>UNIT II - RIGHT UNDERSTANDING (KNOWING) - KNOWER, KNOWN &amp; THE PROCESS</b>                                                                                                                                                                                                                                      | (6) |
| The domain of right understanding starting from understanding the human being (the knower, the experiencer and the doer) and extending up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).                |     |
| <b>UNIT III - UNDERSTANDING HUMAN BEING</b>                                                                                                                                                                                                                                                                           | (6) |
| Understanding the human being comprehensively as the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Basis for harmony/contradiction in the self                                                                   |     |

|                                                                                                                                                                                                                                                                                                                                                                                                          |            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT IV - UNDERSTANDING NATURE AND EXISTENCE</b>                                                                                                                                                                                                                                                                                                                                                      | <b>(6)</b> |
| A comprehensive understanding (knowledge) about the existence, Nature being included; the need and process of inner evolution (through self-exploration, self- awareness and self-evaluation), particularly                                                                                                                                                                                              |            |
| awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).                                                                                                               |            |
| <b>UNIT V - UNDERSTANDING HUMAN CONDUCT, ALL-ENCOMPASSING RESOLUTION AND HOLISTIC WAY OF LIVING</b>                                                                                                                                                                                                                                                                                                      | <b>(6)</b> |
| Understanding Human Conduct, different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All- encompassing Resolution covering all four dimensions of human endeavor viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from Self to Nature and entire Existence |            |
| <b>TOTAL (L:30) : 30 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                         |            |

#### **TEXT BOOK:**

1. R R Gaur, R Asthana, G P Bagaria, 2019 (2nd Revised Edition), A Foundation Course in Human Values and Professional Ethics. ISBN 978-93-87034-47-1, Excel Books, New Delhi

#### **REFERENCES:**

1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA
2. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
4. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome’s report, Universe Books.
5. A Nagraj, 1998, Jeevan Vidya EkParichay, Divya Path Sansthan, Amarkantak.
6. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
7. A N Tripathy, 2003, Human Values, New Age International Publishers
8. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers, Oxford University Press
9. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
10. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati
11. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books
12. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

| Mapping of COs with POs / PSOs |     |   |   |   |   |          |          |          |          |    |          |      |   |
|--------------------------------|-----|---|---|---|---|----------|----------|----------|----------|----|----------|------|---|
| COs                            | POs |   |   |   |   |          |          |          |          |    |          | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6        | 7        | 8        | 9        | 10 | 11       | 1    | 2 |
| 1                              |     |   |   |   |   | 2        | 3        | 2        | 2        |    | 3        |      |   |
| 2                              |     |   |   |   |   | 2        | 3        | 2        | 2        |    | 3        |      |   |
| 3                              |     |   |   |   |   | 2        | 3        | 2        | 2        |    | 3        |      |   |
| 4                              |     |   |   |   |   | 2        | 3        | 2        | 2        |    | 3        |      |   |
| 5                              |     |   |   |   |   | 2        | 3        | 2        | 2        |    | 3        |      |   |
| <b>CO<br/>(W.A)</b>            |     |   |   |   |   | <b>2</b> | <b>3</b> | <b>2</b> | <b>2</b> |    | <b>3</b> |      |   |

M. 48

| 22MEP09 CAD/CAM LABORATORY                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                 |   |   |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------|---|---|
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | L | T               | P | C |
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0 | 0               | 4 | 2 |
| PREREQUISITE: NIL                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   |                 |   |   |
| Course Objectives:                             | <ul style="list-style-type: none"><li>• To gain practical experience in handling 2D drafting and 3D modeling software</li><li>• To gain practical knowledge on assembly of 3D components in a modeling software</li><li>• To know the application of various machine tools like CNC lathe, CNC Vertical Machining Centre</li><li>• To study the features of CNC Machine Tool and modern control systems</li><li>• Learn and apply relevant G-codes and M-codes for threading operations</li></ul> |   |                 |   |   |
| Course Outcomes<br>The student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |   | Cognitive Level |   |   |
| CO1                                            | Construct Three-Dimensional CAD model of the machine component with given specifications                                                                                                                                                                                                                                                                                                                                                                                                          |   | Ap              |   |   |
| CO2                                            | Develop Three-Dimensional assembly model from the generated part models                                                                                                                                                                                                                                                                                                                                                                                                                           |   | Ap              |   |   |
| CO3                                            | Make use of Manual Part Programming to create the prismatic component using CNC Machining Centre                                                                                                                                                                                                                                                                                                                                                                                                  |   | An              |   |   |
| CO4                                            | Apply manual part programming techniques to perform cylindrical turning, thread cutting, and milling operations using canned cycles on CNC turning and milling centre                                                                                                                                                                                                                                                                                                                             |   | Ap              |   |   |
| CO5                                            | Engage in an independent study focusing on modeling various Mechanical components                                                                                                                                                                                                                                                                                                                                                                                                                 |   | C               |   |   |

| LIST OF EXPERIMENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>1. 3D Modelling</b><br>Creation of 3D assembly model of following machine elements using 3D Modeling software<br><br>1. Flange Coupling<br>2. Crosshead<br>3. Lathe Tailstock<br>4. Machine Vice                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
| <b>2. Manual Part Programming.</b><br>(i) Part Programming - CNC Machining Centre<br><br>5. Manual part programming for CNC Milling machine using linear interpolation.<br>6. Manual part programming for CNC Milling machine using Circular interpolation.<br>7. Manual part programming for CNC Milling machine using Canned Cycle Operations<br><br>(ii) Part Programming - CNC Turning Centre<br>8. Manual part programming for CNC turning centre for step turning using linear interpolation<br>9. Manual part programming for CNC turning centre for step turning using circular interpolation<br>10. Manual part programming for CNC turning centre for Thread cutting |  |
| <b>TOTAL (P:60): 60 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |

| Mapping of COs with POs / PSOs |          |          |          |          |          |   |   |          |          |    |          |          |   |
|--------------------------------|----------|----------|----------|----------|----------|---|---|----------|----------|----|----------|----------|---|
| COs                            | POs      |          |          |          |          |   |   |          |          |    |          | PSOs     |   |
|                                | 1        | 2        | 3        | 4        | 5        | 6 | 7 | 8        | 9        | 10 | 11       | 1        | 2 |
| 1                              | 3        |          | 3        |          | 3        |   |   |          | 3        |    |          | 3        |   |
| 2                              |          |          | 3        |          | 3        |   |   |          | 3        |    |          | 3        |   |
| 3                              |          |          | 3        |          | 3        |   |   |          | 3        |    |          | 3        |   |
| 4                              |          |          |          | 3        | 3        |   |   |          | 3        |    |          | 3        |   |
| 5                              |          |          |          | 3        | 3        |   |   | 3        | 3        |    | 3        |          |   |
| <b>CO<br/>(W.A)</b>            | <b>3</b> | <b>-</b> | <b>3</b> | <b>3</b> | <b>3</b> |   |   | <b>3</b> | <b>3</b> |    | <b>3</b> | <b>3</b> |   |

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| 22GED02 - INTERNSHIP / INDUSTRIAL TRAINING            |                                                                                                                                                                                                                                                                                                         |  |                        |          |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|------------------------|----------|
|                                                       |                                                                                                                                                                                                                                                                                                         |  | <b>L</b>               | <b>T</b> |
|                                                       |                                                                                                                                                                                                                                                                                                         |  | <b>P</b>               | <b>C</b> |
|                                                       |                                                                                                                                                                                                                                                                                                         |  | <b>0</b>               | <b>2</b> |
| <b>PREREQUISITE: NIL</b>                              |                                                                                                                                                                                                                                                                                                         |  |                        |          |
| <b>Course Objective:</b>                              | <ul style="list-style-type: none"> <li>Integrate theoretical knowledge acquired in academic coursework into practical applications within industrial or professional environments.</li> <li>Develop a comprehensive understanding of emerging technologies and advancements in the industry.</li> </ul> |  |                        |          |
| <b>Course Outcomes</b><br>The student will be able to |                                                                                                                                                                                                                                                                                                         |  | <b>Cognitive Level</b> |          |
| CO1                                                   | Critically analyze industrial challenges by applying theoretical concepts to real-world problems, demonstrating an ability to diagnose and address technical issues.                                                                                                                                    |  | An                     |          |
| CO2                                                   | Evaluate and assess workplace dynamics, industry trends, and process efficiencies to make data-driven and strategic decisions for improvement.                                                                                                                                                          |  | E                      |          |
| CO3                                                   | Develop and propose innovative engineering solutions by integrating advanced technologies and best industry practices to enhance productivity and sustainability.                                                                                                                                       |  | C                      |          |
| CO4                                                   | Design and execute research-based projects and technical solutions by collaborating in multidisciplinary teams, ensuring effective problem-solving and implementation.                                                                                                                                  |  | C                      |          |
| CO5                                                   | Synthesize and communicate key learnings from industry exposure to enhance leadership, professional ethics, technical writing, and project management skills.                                                                                                                                           |  | C                      |          |

| DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Every student is required to complete 4 weeks of internship (with about 28days), during the Summer/Winter semester breaks. The Internships are evaluated through Internship Reports. The internships can be taken up in an industry, a government organization, a research organization or an academic institution, either in the country or outside the country, that include activities like:</p> <ul style="list-style-type: none"> <li>Successful completion of Internships/ Value Added Programs / Training</li> <li>Programs/ workshops organized by academic Institutions and Industries</li> <li>Soft skill training by the Placement Cell of the college</li> <li>Active association with incubation/ innovation /entrepreneurship cell of the institute;</li> <li>Participation in Inter-Institute innovation related competitions like Hackathons</li> <li>Working for consultancy/ research project within the institutes</li> <li>Participation in activities of Institute's Innovation Council, IPR cell, Leadership</li> <li>Talks, Idea/ Design/ Innovation contests</li> <li>Internship with industry/ NGO"s/ Government organizations/ Micro/ Small/ Medium enterprises</li> <li>Development of a new product/ business plan/ registration of a start-up</li> </ul> |

| Mapping of COs with POs / PSOs |            |   |          |   |   |          |   |          |            |            |            |          |          |
|--------------------------------|------------|---|----------|---|---|----------|---|----------|------------|------------|------------|----------|----------|
| COs                            | POs        |   |          |   |   |          |   |          |            |            |            | PSOs     |          |
|                                | 1          | 2 | 3        | 4 | 5 | 6        | 7 | 8        | 9          | 10         | 11         | 1        | 2        |
| 1                              |            |   |          |   |   |          |   | 2        |            | 2          |            | 3        | 3        |
| 2                              | 3          |   |          |   |   |          |   | 2        | 3          | 3          | 3          | 3        | 3        |
| 3                              | 3          |   |          |   |   |          |   |          | 2          |            | 2          | 3        | 3        |
| 4                              |            |   | 2        |   |   | 3        |   |          |            |            | 3          | 3        | 3        |
| 5                              | 2          |   |          |   |   |          |   |          |            |            |            | 3        | 3        |
| <b>CO<br/>(W.A)</b>            | <b>2.7</b> |   | <b>2</b> |   |   | <b>3</b> |   | <b>2</b> | <b>2.5</b> | <b>2.3</b> | <b>2.7</b> | <b>3</b> | <b>3</b> |

*Amey R*

| 22MED01 - PROJECT WORK                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                 |    |    |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----------------|----|----|
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | L | T               | P  | C  |
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 0 | 0               | 20 | 10 |
| PREREQUISITE: NIL                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                 |    |    |
| Course Objective:                              | <ul style="list-style-type: none"><li>Utilize basic science and engineering principles to address real-world challenges, either individually or as part of a team.</li><li>Develop teamwork, project management, and technical writing abilities to effectively achieve project goals</li><li>Gain expertise in experimental and numerical data collection, along with the use of analytical tools for interpretation and decision-making.</li><li>Conduct literature reviews to identify specific problems and devise systematic methodologies for successful resolution.</li><li>Foster creativity and innovation in solving theoretical and experimental engineering problems, particularly in mechanical engineering applications.</li></ul> |   |                 |    |    |
| Course Outcomes<br>The student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   | Cognitive Level |    |    |
| CO1                                            | Analyze real-world engineering challenges by integrating fundamental scientific and mechanical engineering principles and propose optimal solutions through individual and team-based approaches.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   | An              |    |    |
| CO2                                            | Evaluate project goals by effectively collaborating in teams, managing resources, and demonstrating proficiency in technical writing to communicate engineering solutions professionally.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   | E               |    |    |
| CO3                                            | Interpret and synthesize experimental and numerical data using advanced analytical tools, drawing meaningful conclusions to support engineering decision-making.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   | E               |    |    |
| CO4                                            | Formulate systematic methodologies through critical literature review to identify engineering problems and design structured solutions based on empirical and theoretical insights.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   | C               |    |    |
| CO5                                            | Design and develop innovate mechanical engineering solutions by applying creativity, experimental techniques, and problem-solving strategies to tackle theoretical and practical challenges.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |   | C               |    |    |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>DESCRIPTION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <p>Project work may be allotted to a single student or to a group of students not exceeding 3 per group. The title of project work is approved by head of the department under the guidance of a faculty member and student(s) shall prepare a comprehensive project report after completing the work to the satisfaction of the guide.</p> <p>The Head of the department shall constitute a review committee for project work. There shall be three reviews during the semester by the committee to review the progress. Student(s) shall make presentation on the progress made by him / her / them before the committee and evaluation is done as per Rules and Regulations.</p> |
| <b>TOTAL (P: 300) = 300 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

| Mapping of COs with POs / PSOs |     |     |   |   |   |   |   |   |   |    |    |      |     |
|--------------------------------|-----|-----|---|---|---|---|---|---|---|----|----|------|-----|
| COs                            | POs |     |   |   |   |   |   |   |   |    |    | PSOs |     |
|                                | 1   | 2   | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2   |
| 1                              | 3   |     |   | 3 |   |   |   | 3 |   |    | 3  |      | 2   |
| 2                              |     | 3   |   | 3 |   |   |   | 3 |   |    | 3  |      | 3   |
| 3                              |     | 2   |   |   |   | 3 | 3 | 3 |   |    |    |      |     |
| 4                              | 3   | 3   | 3 | 3 |   | 3 |   | 3 |   |    |    |      |     |
| 5                              |     |     |   |   |   |   |   | 3 | 3 | 3  | 3  | 3    | 3   |
| CO<br>(W.A)                    | 3   | 2.7 | 3 | 3 |   | 3 | 3 | 3 | 3 | 3  | 3  | 3    | 2.7 |

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**22MEX01 - COMPOSITE MATERIALS**

| <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|----------|----------|----------|----------|
| <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**PREREQUISITE : NIL****Course Objective:**

- To introduce the fundamentals and manufacturing aspects of composite materials
- To acquire knowledge on Lamina Constitutive Equations and analysis of laminated flat plates
- To introduce the thermal analysis of various laminates
- To understand various failure criteria related to laminated plates
- To gain knowledge about thermal analysis of composites

**Course Outcomes**

The Student will be able to

**Cognitive Level****Weightage of COs in End Semester Examination**

CO1 Apply the rule of mixtures to predict the properties of composite materials.

Ap

20%

CO2 Analyze the mechanical properties and applications of various composites.

An

20%

CO3 Develop the role of interfaces in composite manufacturing.

Ap

20%

CO4 Make use of strength analysis techniques to predict the failure of laminated plates

Ap

20%

CO5 Evaluate the Coefficient of Thermal Expansion of composites by selecting a thermal analysis

An

20%

**UNIT I- INTRODUCTION TO COMPOSITE MATERIALS****(9)**

Definition - matrix materials - polymers - metals - ceramics - reinforcements - particles, whiskers, inorganic fibers, metal filaments - ceramic fibers - fiber fabrication - natural composite wood, jute - advantages and drawbacks of composites over monolithic materials - mechanical properties and applications of composites, particulate reinforced composite materials, dispersion strengthened composite, fiber reinforced composites - rule of mixtures - characteristics of fiber reinforced composites, manufacturing fiber and composite .

**UNIT II - MANUFACTURING OF COMPOSITES****(9)**

Manufacturing of Polymer Matrix Composites (PMCs) - handlay up, spray technique, filament winding, pultrusion, Resin Transfer Moulding (RTM) - bag moulding, injection moulding, Sandwich Mould Composites (SMC) - manufacturing of Metal Matrix Composites (MMCs) - solid state, liquid state, vapour state processing, manufacturing of Ceramic Matrix Composites (CMCs) - hot pressing - reaction bonding process - infiltration technique, direct oxidation – interfaces.

**UNIT III - INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS****(9)**

Lamina Constitutive Equations: Lamina Assumptions - macroscopic viewpoint - generalized Hooke's Law - reduction to Homogeneous Orthotropic Lamina - Isotropic limit case, Orthotropic Stiffness matrix ( $Q_{ij}$ ), definition of stress and moment resultants - strain displacement relations - basic assumptions of laminated anisotropic plates - laminate constitutive equations - coupling - Interactions, balanced laminates, symmetric laminates, angle ply laminates, cross ply laminates - laminate structural moduli - evaluation of lamina properties from laminate tests - quasi Isotropic laminates - determination of lamina stresses within Laminates.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT IV - LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>(9)</b> |
| Introduction - maximum stress and strain criteria - Von-Misses yield criterion for isotropic materials - generalized Hill's criterion for anisotropic materials - Tsai-Hill's failure criterion for composites - tensor polynomial (Tsai-Wu) - failure criterion - prediction of laminate failure equilibrium equations of motion - energy formulations - static bending analysis - buckling analysis - free vibrations - natural frequencies .                                                                                                                                                                                                                                                 |            |
| <b>UNIT V – THERMAL ANALYSIS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>(9)</b> |
| Assumption of constant Coefficient of Thermal Expansion (C.T.E.) - modification of Hooke's law - modification of laminate constitutive equations - orthotropic lamina C.T.E's - C.T.E's for special laminate configurations - unidirectional, off-axis, symmetric balanced laminates, zero C.T.E laminates, thermally quasi-isotropic laminates                                                                                                                                                                                                                                                                                                                                                 |            |
| <b>TEXT BOOKS</b><br>1. Malik, P.K., "Fiber Reinforced Composite: Materials, Manufacturing and Design", 3rd ed., CRC Press, 2007<br>2. Ronald F. Gibson, "Principles of Composite Material Mechanics ", 2nd ed., CRC Press, 2007                                                                                                                                                                                                                                                                                                                                                                                                                                                                |            |
| <b>REFERENCES:</b><br>1. Michael Hyer and Scott R White, " Stress Analysis of Fibre Reinforced Composite Materials", International edition, McGraw-Hill Education, 1998<br>2. Issac M. Daniel and Oril Shai, "Engineering Mechanics of Composite Materials", 2nd ed., Oxford University Press, 2005<br>3. Bhagwan D. Agarwal, Lawrence J. Broutman and K. Chandrashekhara, "Analysis and Performance of Fiber Composites", 3rd ed., Wiley Publications, 2012<br>4. Mallick.P.K and Newman.S, "Composite Materials Technology: Processes and Properties", Hanser Gardner Publications, 1991<br>5. Deborah D. L. Chung, " Composite Materials: Science and Applications", 2nd ed., Springer, 2012 |            |

| Mapping of COs with POs / PSO's |     |   |   |   |   |   |   |   |   |    |    |      |   |
|---------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                             | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                 | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                               | 2   | 2 | 2 |   |   |   | 2 |   | 1 |    | 2  | 1    | 2 |
| 2                               | 2   | 2 | 2 | 1 |   | 2 | 2 |   | 1 |    | 2  | 1    | 2 |
| 3                               | 2   | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 |    | 2  | 1    | 2 |
| 4                               | 2   | 2 | 2 | 1 |   |   | 2 |   | 1 |    | 2  | 1    | 2 |
| 5                               | 2   | 2 | 2 | 1 | 1 |   | 2 | 1 | 1 |    | 2  | 1    | 2 |
| <b>CO (W.A)</b>                 | 2   | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 |    | 2  | 1    | 2 |

| 22MEX02 - TOOL DESIGN                          |                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                              |   |   |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                |                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                         | L               | T                                            | P | C |
|                                                |                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                         | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                              |   |   |
| Course Objective:                              |                                                                                                                   | <ul style="list-style-type: none"><li>• To teach students the fundamentals of work holding devices.</li><li>• To enable the students design tools, dies, jigs and fixtures.</li><li>• To teach students to analyze and optimize an existing jigs.</li><li>• To gain knowledge about the design of various fixtures.</li><li>• To expose students to design of dies for press work and forging</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                         | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply general considerations in the design of jigs and fixtures and their methods of construction.                |                                                                                                                                                                                                                                                                                                                                                                                                         | Ap              | 20%                                          |   |   |
| CO2                                            | Apply principles of mechanical, pneumatic, and hydraulic clamping.                                                |                                                                                                                                                                                                                                                                                                                                                                                                         | Ap              | 20%                                          |   |   |
| CO3                                            | Comprehend the metal cutting process and selection of appropriate tool materials                                  |                                                                                                                                                                                                                                                                                                                                                                                                         | Ap              | 20%                                          |   |   |
| CO4                                            | Analyze the required specifications of a press for required operations                                            |                                                                                                                                                                                                                                                                                                                                                                                                         | An              | 20%                                          |   |   |
| CO5                                            | Identify the importance of forging die design, including flow lines, parting lines, and materials for die blocks. |                                                                                                                                                                                                                                                                                                                                                                                                         | An              | 20%                                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                              |            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I- DESIGN OF CUTTING TOOLS</b>                                                                                                                                                                                                                                                                                                                                                       | <b>(9)</b> |
| Metal cutting process - selection of tool materials - design of single point and multipoint cutting tool - form tools, drills, milling cutters, broaches and chip breakers - problems on design of single point cutting tools only .                                                                                                                                                         |            |
| <b>UNIT II - LOCATING AND CLAMPING METHODS</b>                                                                                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Basic principles of location - locating methods and devices - principles of clamping - mechanical, pneumatic and hydraulic actuation - clamping force analysis - design problems.                                                                                                                                                                                                            |            |
| <b>UNIT III - DESIGN OF JIGS</b>                                                                                                                                                                                                                                                                                                                                                             | <b>(9)</b> |
| Types of drill jigs - general considerations in the design of drill jigs - drill bushings - types, methods of construction- simple designs of plate, channel, boxes, post, angle plate, turnovers and pot jigs.                                                                                                                                                                              |            |
| <b>UNIT IV - DESIGN OF FIXTURES</b>                                                                                                                                                                                                                                                                                                                                                          | <b>(9)</b> |
| Design principles - types of fixtures - fixtures for machine tools: lathe, milling, boring, broaching and grinding - assembly fixtures - inspection and welding fixtures.                                                                                                                                                                                                                    |            |
| <b>UNIT V – DESIGN OF DIES</b>                                                                                                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Press tools - Fundamentals of die-cutting operations - Cutting action in punch and die operations - Die clearance - Blanking and Piercing Die construction - Pilots - Strippers and Pressure Pads - Press work materials - Strip layout - Design of simple progressive and compound die sets - Forging Die - Flow lines, parting lines, open and close die forging; Materials for die block. |            |
| <b>TEXT BOOKS</b><br>1. Donaldson, Lecain and Goold, “Tool Design”, 3rd ed., Tata McGraw Hill, 2012<br>2. John G. Nee, “Tool Design”, 6th ed., Society of Manufacturing Engineers, 2010                                                                                                                                                                                                      |            |

**REFERENCES:**

1. Venkataraman. K, "Design of Jigs Fixtures and Press Tools", Tata McGraw Hill, New Delhi, 2005
2. Joshi. P.H, "Jigs and Fixtures", 2nd ed., Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2004
3. Elanchezhian. C, "Design of Jigs Fixtures and Press Tools", Eswar Press, Chennai, 2004
4. Hoffman, "Jigs and Fixture Design", Thomson Delmar Learning, Singapore, 2004
5. Vukota Boljanovic Paquin .J. R, "Die Design Fundamentals", 3rd ed., Industrial Press, 2005

**Mapping of COs with POs / PSOs**

| COs                 | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|---------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|                     | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                   | 2   | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |    | 2  | 2    |   |
| 2                   | 2   | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |    | 2  | 2    |   |
| 3                   | 2   | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |    | 2  | 2    |   |
| 4                   | 2   | 2 | 2 | 2 | 2 |   |   |   |   |    |    | 2    |   |
| 5                   | 2   | 2 | 2 | 2 | 2 | 2 |   |   |   |    |    | 2    |   |
| <b>CO<br/>(W.A)</b> | 2   | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |    | 2  | 2    |   |





| 22MEX03 - NON TRADITIONAL MACHINING PROCESSES  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                                              |          |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|----------|
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>L</b>        | <b>T</b>                                     | <b>P</b> |
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>3</b>        | <b>0</b>                                     | <b>0</b> |
| <b>PREREQUISITE : NIL</b>                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |                                              |          |
| <b>Course Objective:</b>                       | <ul style="list-style-type: none"> <li>To classify non-traditional machining processes and describe mechanical energy based non-traditional machining processes.</li> <li>To differentiate chemical and electro chemical energy-based processes.</li> <li>To describe thermo-electric energy-based processes</li> <li>To explain nano finishing processes.</li> <li>To introduce hybrid non-traditional machining processes and differentiate hybrid non-traditional machining processes.</li> </ul> |                 |                                              |          |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Cognitive Level | Weightage of COs in End Semester Examination |          |
| CO1                                            | Formulate different types of non-traditional machining processes and evaluate mechanical energy based non-traditional machining processes.                                                                                                                                                                                                                                                                                                                                                           | Ap              | 40%                                          |          |
| CO2                                            | Investigate the mechanisms and characteristics of mechanical energy-based processes, such as Ultrasonic Machining and Water Jet Machining.                                                                                                                                                                                                                                                                                                                                                           | An              | 20%                                          |          |
| CO3                                            | Compare the advantages and limitations of USM and WJM against other non-traditional methods, such as EDM or Laser Machining, with respect to specific manufacturing scenarios.                                                                                                                                                                                                                                                                                                                       | E               | 20%                                          |          |
| CO4                                            | Develop criteria for selecting nano finishing processes by integrating knowledge of material properties, desired surface finish, and production volume.                                                                                                                                                                                                                                                                                                                                              | An              | 20%                                          |          |
| CO5                                            | Analyse hybrid non-traditional machining processes and differentiate non- traditional machining processes.                                                                                                                                                                                                                                                                                                                                                                                           | An              | Internal Assessment                          |          |

|                                                                                                                                                                                                                                                                                                                                                                                         |            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES</b>                                                                                                                                                                                                                                                                                                                      | <b>(9)</b> |
| Introduction - Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining their principles, equipment, effect of process parameters, applications, advantages and limitations. |            |
| <b>UNIT II - CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES</b>                                                                                                                                                                                                                                                                                                                   | <b>(9)</b> |
| Principles, equipments, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding, Electro chemical deburring.                                                                                                                                                       |            |
| <b>UNIT III - THERMO-ELECTRIC ENERGY BASED PROCESSES</b>                                                                                                                                                                                                                                                                                                                                | <b>(9)</b> |
| Principles, equipments, effect of process parameters, applications, advantages and limitations of Electric discharge machining, Wire electric discharge machining, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.                                                                                                                             |            |
| <b>UNIT IV - NANO FINISHING PROCESSES</b>                                                                                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Principles, equipments, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magneto rheological finishing, Magneto rheological abrasive flow finishing.                                                                                                                        |            |
| <b>UNIT V – HYBRID NON-TRADITIONAL MACHINING PROCESSES</b>                                                                                                                                                                                                                                                                                                                              | <b>(9)</b> |
| Introduction - Various hybrid non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non-traditional machining processes.                                                                                                                             |            |

**TEXT BOOKS:**

1. Adit han. M., "Unconventional Machining Processes", Atlantic, New Delhi, India, 2009. ISBN 13: 9788126910458
2. Ana nd Pandey, "Modern Machining Processes", Ane Books Pvt. Ltd., New Delhi, India, 2019.

**REFERENCES:**

1. Benedict, G.F., "Non-traditional Manufacturing Processes", Marcel Dekker Inc., New York 1987. ISBN-13: 978-0824773526.
2. Carl Sommer, "Non-Traditional Machining Handbook", Advance Publishing., United States, 2000, ISBN-13: 978-1575373256.
3. Golam Kibria, Bhattacharyya B. and Paulo Davim J., "Non-traditional Micromachining Processes: Fundamentals and Applications", Springer International Publishing., Switzerland, 2017, ISBN:978-3-319-52008-7.
4. Jagadeesha T., "Non-Traditional Machining Processes", I.K. International Publishing House Pvt. Ltd., New Delhi, India, 2017, ISBN-13: 978-9385909122.
5. Kapil Gupta, Neelesh K. Jain and Laubscher R.F., "Hybrid Machining Processes: Perspectives on Machining and Finishing", 1st edition, Springer International Publishing., Switzerland, 2016, ISBN- 13: 978-3319259208.

| Mapping of COs with POs / PSOs |     |   |     |   |     |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|-----|---|-----|---|---|---|---|----|----|------|---|
| CO                             | POs |   |     |   |     |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3   | 4 | 5   | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   | 1   |   | 1   | 1 |   | 1 | 1 |    | 1  | 2    | 2 |
| 2                              | 3   |   | 1   |   | 1   | 1 |   | 1 | 1 |    | 1  | 2    | 2 |
| 3                              | 3   |   | 1   |   | 1   | 1 |   | 1 | 1 |    | 1  | 2    | 2 |
| 4                              | 3   |   | 2   |   | 1   | 1 |   | 1 | 1 |    | 1  | 2    | 2 |
| 5                              | 3   |   | 3   |   | 3   | 1 |   | 1 | 1 |    | 1  | 2    | 2 |
| CO (W.A)                       | 3   |   | 1.6 |   | 1.4 | 1 |   | 1 | 1 |    | 1  | 2    | 2 |

| 22MEX04 - DESIGN CONCEPTS IN ENGINEERING       |                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                              |   |   |
|------------------------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                |                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | L               | T                                            | P | C |
|                                                |                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                              |   |   |
| Course Objective:                              |                                                                                                                | <ul style="list-style-type: none"><li>• To study the various design requirements and get acquainted with the processes involved in product development.</li><li>• To study the design processes to develop a successful product.</li><li>• To learn scientific approaches to provide design solutions.</li><li>• Designing solution through relate the human needs and provide a solution.</li><li>• To study the principles of material selection, costing and manufacturing in design.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Analyze the various design requirements and get acquainted with the processes involved in product development. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | An              | 20%                                          |   |   |
| CO2                                            | Apply the design processes to develop a successful product.                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Ap              | 20%                                          |   |   |
| CO3                                            | Apply scientific approaches to provide design solutions.                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Ap              | 20%                                          |   |   |
| CO4                                            | Design solution through relate the human needs and provide a solution.                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | C               | 20%                                          |   |   |
| CO5                                            | Apply the principles of material selection, costing and manufacturing in design.                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Ap              | 20%                                          |   |   |

|                                                                                                                                                                                                                                                                                                                   |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I- DESIGN TERMINOLOGY</b>                                                                                                                                                                                                                                                                                 | <b>(9)</b> |
| Definition-various methods and types of design-importance of product design-various design projects-morphology of design-requirements of a good design-design guidelines-design catalogs-codes and standards-design product and process cycles-bench marking.                                                     |            |
| <b>UNIT II - INTRODUCTION TO DESIGN PROCESSES</b>                                                                                                                                                                                                                                                                 | <b>(9)</b> |
| Basic modules in design process-scientific method and design method- identification, importance of problem - structured problem, real life problem- information gathering -customer requirements- Quality Function Deployment (QFD)- Detail design and engineering drawings-prototyping and testing-Design for X. |            |
| <b>UNIT III - CREATIVITY IN DESIGN</b>                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Creativity and problem solving-vertical and lateral thinking-invention, innovation, diffusion-psychological view, mental blocks- Creativity methods-brainstorming, mind map, concept map-Theory of innovative problem solving (TRIZ) –Axiomatic design.                                                           |            |
| <b>UNIT IV - HUMAN AND SOCIETAL ASPECTS IN PRODUCT DEVELOPMENT</b>                                                                                                                                                                                                                                                | <b>(9)</b> |
| Human factors in design, ergonomics, user friendly design-Aesthetics and visual aspects - environmental aspects-marketing aspects-team aspects-legal aspects-presentation aspects                                                                                                                                 |            |
| <b>UNIT V – MATERIAL AND PROCESSES IN DESIGN</b>                                                                                                                                                                                                                                                                  | <b>(9)</b> |

Material selection for performance characteristics of materials-selection for new design substitution for existing design-economics of materials-selection methods-recycling and material selection-types of manufacturing process, process systems-Design for Manufacture (DFM)-Design for Assembly (DFA).

**TOTAL (L:45) = 45 PERIODS**

**TEXT BOOKS:**

1. Dieter. G. N., Linda C. Schmidt, "Engineering Design", McGraw Hill, 2013.
2. Horenstein, M. N., Design Concepts for Engineers, Prentice Hall, 2010.

**REFERENCES:**

1. Edward B. Magrab, Satyandra K. Gupta, F. Patrick McCluskey and Peter A. Sandborn, "Integrated Product and Process Design and Development", CRC Press, 2009.
2. Sumesh Krishnan and MukulSukla, Concepts in Engineering Design, Notion Press, 2016.
3. Joseph E. Shigley, Charles R.Mische, and Richard G. Budynas, "Mechanical Engineering Design", McGraw Hill Professional, 2003.
4. Atif Aziz, "Concepts in Engineering Design", New Age International, 2017
5. Dhillon, B. S., Advanced Design Concepts for Engineers, Technomic Publishing Co., 1998.

**Mapping of COs with POs / PSOs**

| COs                 | POs        |            |            |          |          |   |   |   |          |          |          | PSOs       |   |
|---------------------|------------|------------|------------|----------|----------|---|---|---|----------|----------|----------|------------|---|
|                     | 1          | 2          | 3          | 4        | 5        | 6 | 7 | 8 | 9        | 10       | 11       | 1          | 2 |
| 1                   | 2          | 3          |            | 1        |          |   |   |   |          |          |          | 3          |   |
| 2                   | 3          |            | 1          |          |          |   |   |   |          |          |          | 2          |   |
| 3                   | 2          |            | 3          | 1        |          |   |   |   |          |          |          | 2          |   |
| 4                   |            | 2          | 3          |          | 1        |   |   |   |          |          |          | 1          |   |
| 5                   |            |            |            |          |          |   |   |   | 1        | 2        | 2        | 1          |   |
| <b>CO<br/>(W.A)</b> | <b>2.3</b> | <b>2.5</b> | <b>2.3</b> | <b>1</b> | <b>1</b> |   |   |   | <b>1</b> | <b>2</b> | <b>2</b> | <b>1.8</b> |   |

| 22MEX05 - DESIGN OF TRANSMISSION SYSTEMS                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                      | L                                                                                                                                                                                                                                                                                                             | T                                            | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                      | 2                                                                                                                                                                                                                                                                                                             | 1                                            | 0 | 3 |
| PREREQUISITE : 22MECI4                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| Course Objective:                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                      | <ul style="list-style-type: none"><li>To understand and apply the fundamental design principles</li><li>To analyze complex gear drive problems</li><li>To design and draft gearbox layouts</li><li>To evaluate mechanical power transmission systems</li><li>To implement standards and regulations</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                      | Cognitive Level                                                                                                                                                                                                                                                                                               | Weightage of COs in End Semester Examination |   |   |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                     | Apply fundamental design principles to calculate and select parameters for flat belts, V-belt drives and transmission chains                         | Ap                                                                                                                                                                                                                                                                                                            | 20%                                          |   |   |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                     | Analyze complex problems related to spur, helical, bevel and worm gear drives by considering factors like materials, loads, stresses and efficiency. | An                                                                                                                                                                                                                                                                                                            | 40%                                          |   |   |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                     | Design the multistage gear box and draft the kinematic arrangement and ray diagram.                                                                  | An                                                                                                                                                                                                                                                                                                            | 20%                                          |   |   |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                     | Apply design principles to calculate and select parameters for clutches and brakes                                                                   | Ap                                                                                                                                                                                                                                                                                                            | 20%                                          |   |   |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                     | Implement standards, codes, and regulations in transmission system design.                                                                           | U                                                                                                                                                                                                                                                                                                             | Internal Assessment                          |   |   |
| UNIT I - DESIGN OF FLEXIBLE POWER TRANSMISSION SYSTEMS                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| (6+3)                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| Design flat belt and V belt drive based on manufacturer's catalogue- design of transmission chains and sprockets. Introduction to timing belt and silent chain.                                                                                                                                                                                                                                         |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| UNIT II - SPUR GEARS AND HELICAL GEARS                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| (6+3)                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| Gear materials- design of straight tooth spur gear & Parallel axis helical gears based on speed ratio, number of teeth, Fatigue strength, Factor of safety, Strength and wear considerations. Forces on teeth-stresses on teeth-gear failures-Helical gear-Module-Normal and transverse, Equivalent number of teeth.                                                                                    |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| UNIT III - BEVEL AND WORM GEARS                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| (6+3)                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| Straight bevel gear: Gear materials - tooth terminology - tooth forces and stresses – Design of straight bevel gears based on speed ratio, number of teeth, Fatigue strength, Factor of safety, Strength and wear considerations – Worm gear: Gear materials –tooth terminology, Thermal capacity, Forces and stresses, efficiency, design of worm gear drive by checking surface and bending stresses. |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| UNIT IV - DESIGN OF GEAR BOXES                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| (6+3)                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| Gear boxes - speed selection - geometric progression - standard step ratio - ray diagram, kinematic layout - design of multistage multi speed constant mesh gear boxes. Introduction to automobile gear box design.                                                                                                                                                                                     |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| UNIT V - MOTION CONTROL: CLUTCHES AND BRAKES                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| (6+3)                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| Clutches - types - materials - design of single plate, multi plate and cone clutches - brakes - types - friction materials – design of single block brake, simple band brake, and internal expanding brake. Introduction to Design of Disc brake.                                                                                                                                                       |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| TOTAL (L:30 +T:15) = 45 PERIODS                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                      |                                                                                                                                                                                                                                                                                                               |                                              |   |   |

| Sl.No | Practice Titles                    | Unit |
|-------|------------------------------------|------|
| 1     | Flat belt and V belt drive         | 1    |
| 2     | Design of straight tooth spur gear | 2    |
| 3     | Design of straight bevel gears     | 3    |

#### TEXTBOOKS:

1. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett "Mechanical Engineering Design", 10th ed., Tata McGraw-Hill, 2015
2. Bhandari V.B, "Design of Machine Elements", 4th ed., Tata McGraw-Hill Book Co, 2017

#### REFERENCES:

1. Jalaludeen S.Md, "Machine Design (Volume-2)", 4th ed., Anuradha Publications, Chennai, 2012
2. Robert C. Juvinall, Kurt M. Marshek, "Machine Component Design", Wiley India Pvt Ltd., 2016
3. Sharma P. C, Aggarwal D. K., "A Textbook of Machine Design" S K Kataria & Sons-New Delhi, 2013
4. Spotts M. F, Shoup T. E , Hornberger L.E , David O. Kazmer, "Design of Machine Elements", 8th ed., Pearson India, 2006
5. Sundararajamoorthy T. V, Shanmugam .N, "Machine Design", Anuradha Publications, Chennai, 200

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 2                              |     | 3 |   |   |   |   |   |   |   |    |    | 3    |   |
| 3                              |     |   | 3 |   |   |   |   |   |   |    |    | 3    |   |
| 4                              | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 5                              |     |   |   |   |   | 2 | 2 |   |   |    |    | 2    |   |
| CO (W.A)                       | 3   | 3 | 3 | - | - | 2 | 2 | - | - | -  | -  | 3    | - |

| 22MEX06 - AUTOMOBILE ENGINEERING               |                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                              |   |   |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                                           | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | T                                            | P | C |
|                                                |                                                                                                                                                           | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0                                            | 0 | 3 |
| PREREQUISITE : 22MEC09                         |                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                              |   |   |
| Course Objective:                              |                                                                                                                                                           | <ul style="list-style-type: none"><li>• To introduce the types of automobiles, structure and construction details</li><li>• To acquire knowledge on engine auxiliary system and ignition systems</li><li>• To know about the engine transmission systems</li><li>• To learn the working principle of steering, brakes and suspension systems</li><li>• To introduce the types of emissions in automobiles, emission control techniques and advanced technologies</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                           | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply knowledge of vehicle structure, engine components, and auxiliary systems to analyze construction, functions, and performance of automobile systems. | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 40%                                          |   |   |
| CO2                                            | Apply transmission system concepts to analyze the construction and operation of clutches, gearboxes, and driveline components.                            | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 20%                                          |   |   |
| CO3                                            | Apply principles of steering, braking, and suspension systems to evaluate their construction, types and functionality.                                    | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 20%                                          |   |   |
| CO4                                            | Analyze emission control and automotive safety systems to assess their standards, functions, and technological advancements.                              | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 20%                                          |   |   |
| CO5                                            | Seminar presentation on recent technologies in the field of automobiles                                                                                   | U                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT I - VEHICLE STRUCTURE AND ENGINE COMPONENTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | (9) |
| Types of automobiles - vehicle construction and layouts - chassis - frame and body – Vehicle aerodynamics, resistances and moments - components of IC engines- their forms, functions and materials – cooling system - lubrication system.                                                                                                                                                                                                                                                                                               |     |
| <b>UNIT II - ENGINE AUXILIARY SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | (9) |
| Fuel supply system, Simple Carburetor - electronically controlled gasoline injection system for SI engines - Mono point and multi point fuel injection system - electronically controlled diesel injection system - rotary distributor type, CRDI, unit injector system - Ignition system - battery coil ignition system, magneto coil ignition system, electronic coil ignition system (Transistorized coil ignition system, capacitive discharge ignition system) -Turbo charger - super charger - electronic engine management system |     |
| <b>UNIT III - TRANSMISSION SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | (9) |
| Clutch - Types and construction - single plate, multi plate, diaphragm clutch - types of gear boxes - sliding mesh, constant mesh, synchromesh - gear shifting mechanism - overdrive – transfer box- fluid flywheel - torque converter - propeller shaft - slip joint - universal joint - differential - Hotchkiss drive and torque tube drive.                                                                                                                                                                                          |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT IV - STEERING, BRAKES AND SUSPENSION SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                                                         | (9) |
| Principle of steering - steering geometry - steering linkages - steering gear box - power steering – Direct adaptive steering - brakes - types and construction - drum brake, disc brake, pneumatic braking system, hydraulic braking system, anti lock braking system (ABS) - types of front and rear axle - suspension system - types and construction - coil spring, leaf spring, stabilizer bars- air suspension -shock absorber             |     |
| <b>UNIT V - EMISSION CONTROL, SAFETY SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                                                                 | (9) |
| Automobile emissions - standards - Control techniques - exhaust gas recirculation - 3 way catalytic converter - Safety standards for automobiles - seat belts - air bags -Electronic Brake Distribution (EBD) - Electronic Stability Program (ESP) - Traction Control System (TCS) - Global Positioning System (GPS) - Collision avoiding system, low tire pressure warning system, driver information system. Blind spot detection and warning. |     |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                 |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 1. Babu.A.K and Ajit Pal Singh, “Automobile Engineering”, 1st ed., S.Chand Publications, 2014<br>2. Kirpal Singh, “Automobile Engineering Vol.I and 2”, Standard Publishers, New Delhi, 2021                                                                                                                                                                                                                                                                                                                                                             |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 1. William H. Crouse and Donald L Anglin, “Automotive Mechanics”, McGraw Hill Education (India) Private Limited, 10th Edition, 2017<br>2. Rajput.R.K, “A textbook Automobile Engineering” Laxmi Publishers, 3rd ed., New Delhi, 2018<br>3. Ramakrishna K, “Automobile Engineering”, Prentice Hall India Learning Private Limited, 2012<br>4. Srinivasan.S, “Automotive Mechanics”, 2nd ed., McGraw Hill Education (India) Private Limited, 2017<br>5. Jain K.K and Asthana.R.B, “Automobile Engineering”, 1st ed., McGraw Hill Education Pvt. Ltd., 2017 |

| Mapping of COs with POs / PSOs |          |          |   |   |   |   |   |   |          |    |    |          |   |
|--------------------------------|----------|----------|---|---|---|---|---|---|----------|----|----|----------|---|
| COs                            | POs      |          |   |   |   |   |   |   |          |    |    | PSOs     |   |
|                                | 1        | 2        | 3 | 4 | 5 | 6 | 7 | 8 | 9        | 10 | 11 | 1        | 2 |
| 1                              | 3        |          |   |   |   |   |   |   |          |    |    | 2        |   |
| 2                              | 3        |          |   |   |   |   |   |   |          |    |    | 2        |   |
| 3                              | 3        |          |   |   |   |   |   |   |          |    |    | 2        |   |
| 4                              | 3        | 2        |   |   |   |   |   |   |          |    |    | 2        |   |
| 5                              |          |          |   |   |   |   |   |   | 2        |    |    |          |   |
| <b>CO (W.A)</b>                | <b>3</b> | <b>2</b> |   |   |   |   |   |   | <b>2</b> |    |    | <b>2</b> |   |



| 22MEX07 - INDUSTRIAL LAYOUT DESIGN AND SAFETY |                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              |   |   |
|-----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                               |                                                                                                                                      | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | T                                            | P | C |
|                                               |                                                                                                                                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                            |                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              |   |   |
| Course Objective:                             |                                                                                                                                      | <ul style="list-style-type: none"><li>• To introduce the industrial facility layout design principles, process and material flow analysis and product and equipment analysis.</li><li>• To learn the facilities layout design algorithms and selecting appropriate software.</li><li>• To study the facilities layout problem modelling tools and algorithms for production, warehouse, and material handling.</li><li>• To learn the safety planning and management principles in industries.</li><li>• To learn the various safety management approaches in industries.</li></ul> |                                              |   |   |
| Course Outcomes                               |                                                                                                                                      | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Weightage of COs in End Semester Examination |   |   |
| The Student will be able to                   |                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              |   |   |
| CO1                                           | Analyze industrial facility layout design principles, process and material flow analysis and product and equipment analysis.         | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 20%                                          |   |   |
| CO2                                           | Apply the engineering design problem approach to analyze products, select equipment and analyze space requirements and availability. | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 20%                                          |   |   |
| CO3                                           | Upgrade safety developmental programs by implementing safety procedures, arrangements, and performance measures.                     | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 20%                                          |   |   |
| CO4                                           | Evaluate safety performance by understanding accidents, occupational health, and industrial hygiene.                                 | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 20%                                          |   |   |
| CO5                                           | Illustrate the various safety management approaches in industries.                                                                   | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 20%                                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I- INTRODUCTION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>(9)</b> |
| Industrial Facility Layout: Definition, Types of Layout Problems, Engineering Design Problem Approach – Product Analysis, Equipment Selection, Personnel Requirement Analysis, Space Requirement and Availability – Process and Material Flow Analysis, Data Requirement for Layout Decisions, Tools for Presenting Layout Designs.                                                                                                                              |            |
| <b>UNIT II - FACILITIES LAYOUT DESIGN &amp; ALGORITHMS</b>                                                                                                                                                                                                                                                                                                                                                                                                       | <b>(9)</b> |
| .Traditional Approaches to Facility Layout, Systematic Layout Planning, Special Considerations in Office Layout, Engineering Design Problem Approach, Code Compliance, OSHA, ADA Regulations, and Other Considerations in Facility Design – Algorithms for the Layout Problem, Construction Algorithms, Improvement Algorithms, Hybrid Algorithms, Layout Software (CRAFT, BLOCPLAN, PFAST, Layout-iQ, VIP-PLANOPT, Factory CAD, Factory FLOW, Plant Simulation) |            |
| <b>UNIT III - FACILITIES LAYOUT PROBLEM MODELS &amp; ALGORITHMS</b>                                                                                                                                                                                                                                                                                                                                                                                              | <b>(9)</b> |
| Models for the Layout Problem, Generic Modeling Tools, Models for the Single-Row Layout Problem, Models for the Multi row Layout Problem with Departments of Equal and Unequal Area – Material Handling, Principles, Types, Models for Material-Handling System Design – Storage and Warehousing, Warehouse Functions, Warehouse Design and Operation.                                                                                                           |            |
| <b>UNIT IV - SAFETY PLANNING &amp; MANAGEMENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                | <b>(9)</b> |
| Introduction: Elements of Safety Programming, Safety Management. Upgrading Safety Developmental Programs:                                                                                                                                                                                                                                                                                                                                                        |            |

Safety Procedures, Arrangements and Performance Measures, Education, Training and Development in Safety. Safety Performance: An Overview of an Accident, Occupational Health and Industrial Hygiene. Understanding the Risks: Prevention of Accidents Involving Hazardous Substances. Indian Factories Act 1948 for Health and Safety. .

## UNIT V – APPROACHES IN SAFETY MANAGEMENT

(9)

Safeguarding against Common Potential Hazards: Trips, Slips and Falls, Preventing Electrocution, Static Electricity, Hazardous Energy Control. Specific Hazard Control Measures: Forklift Hazard Control, Tractor Hazard Control. Safe Handling and Storage: Material Handling, Compressed Gas Cylinders, Corrosive Substances, Hydrocarbons, Waste Drums and Containers.

### TEXT BOOKS

1. Sunderesh S. Heragu, "Facilities Design", 3rd Edition, CRC Press Taylor & Francis Group, 2008.
2. L. M. Deshmukh, "Industrial Safety Management: Hazard Identification and Risk Control", Tata McGraw-Hill Publishing Co. Ltd., 2005.

### REFERENCES:

1. Eric Teicholz, "Facility Design and Management Handbook", Tata McGraw-Hill Publishing Co. Ltd., 2001.
2. James A. Tompkins, John A. White, Yavuz A. Bozer, and J. M. A. Tanchoco, "Facilities Planning", 4th Edition, John Wiley & Sons, 2010.
3. Matthew P. Stevens and Fred E. Meyers, "Manufacturing Facilities Design and Material Handling", 5th Edition, Purdue University Press, 2013.
4. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003.
5. J. Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017.
6. Industrial Hazard and Safety Handbook: (Revised impression by Ralph W King and John Magid | 24 September 2013)

### Mapping of COs with POs / PSOs

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        | 1   | 2 | 2 | 2 |   | 3 | 3 | 2 | 1 |    | 3  | 2    | 2 |
| 2        | 1   | 2 | 2 | 2 |   | 3 | 3 | 2 | 1 | 1  | 3  | 2    | 2 |
| 3        |     |   |   |   |   | 3 | 3 |   |   |    |    | 2    | 2 |
| 4        |     | 2 |   | 2 |   |   |   |   |   |    |    | 2    | 2 |
| 5        |     |   |   |   |   | 3 | 3 |   |   |    |    | 2    | 2 |
| CO (W.A) | 1   | 2 | 2 | 2 |   | 3 | 3 | 2 | 1 | 1  | 3  | 2    | 2 |

| 22MEX08 – MODERN ROBOTICS                      |                                                                        |                                                                                                                                                                                                                                                                                                                                                                          |                 |                                              |   |   |
|------------------------------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                |                                                                        |                                                                                                                                                                                                                                                                                                                                                                          | L               | T                                            | P | C |
|                                                |                                                                        |                                                                                                                                                                                                                                                                                                                                                                          | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                        |                                                                                                                                                                                                                                                                                                                                                                          |                 |                                              |   |   |
| Course Objective:                              |                                                                        | <ul style="list-style-type: none"><li>• To introduce definition, history of robotics and robot anatomy.</li><li>• To learn the simulation of robot kinematics</li><li>• To study the grasping and manipulation of robots.</li><li>• To study about mobile robot and manipulation.</li><li>• To study the applications of industrial, service, domestic robots.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                        |                                                                                                                                                                                                                                                                                                                                                                          | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply the definition, history of robotics and robot anatomy.           |                                                                                                                                                                                                                                                                                                                                                                          | Ap              | 20%                                          |   |   |
| CO2                                            | Design and Develop the simulation of robot kinematics                  |                                                                                                                                                                                                                                                                                                                                                                          | An              | 20%                                          |   |   |
| CO3                                            | Optimize ethical knowledge in the grasping and manipulation of robots. |                                                                                                                                                                                                                                                                                                                                                                          | An              | 40%                                          |   |   |
| CO4                                            | Establish real time working about mobile robot and manipulation.       |                                                                                                                                                                                                                                                                                                                                                                          | Ap              | 20%                                          |   |   |
| CO5                                            | Manipulate the applications of industrial, service, domestic robots.   |                                                                                                                                                                                                                                                                                                                                                                          | An              | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT I - INTRODUCTION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | (9) |
| Robot: Definition, History of Robotics, Robot Anatomy, Co-ordinate systems, types and classification, Configuration space and degrees of freedom of rigid bodies and robots, Configuration space topology and representation; configuration and velocity constraints; task space and workspace, Rigid-body motions, rotation matrices, angular velocities, and exponential coordinates of rotation, Homogeneous transformation matrices.                                                                                     |     |
| <b>UNIT II - SIMULATION OF ROBOT KINEMATICS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | (9) |
| Robot kinematics, Forward and inverse kinematics (two three four degrees of freedom), Forward and inverse kinematics of velocity, Homogeneous transformation matrices, translation and rotation matrices Denavit and Hartenberg (D-H) transformation, Dynamics of Open Chains, Trajectory Generation, motion planning, robot control: First- and second-order linear error dynamics, stability of a feedback control system. Sensors- Infrared, Temperature, Proximity, Ultrasonic, Gyroscope, Hall effect and Light sensor. |     |
| <b>UNIT III - GRASPING AND MANIPULATION OF ROBOTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | (9) |
| Kinematics of contact, contact types (rolling, sliding, and breaking), graphical methods for representing kinematic constraints in the plane, and form-closure grasping, Coulomb friction, friction cones, graphical methods for representing forces and torques in the plane, End effectors, grippers, types of gripper, gripper force analysis, and examples of manipulation and grasping.                                                                                                                                 |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT IV - MOBILE ROBOTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | (9) |
| Mobile robot, Wheeled Mobile Robots: Kinematic models of omnidirectional and non-holonomic wheeled mobile robots, Controllability, motion planning, feedback control of non-holonomic wheeled mobile robots; odometry for wheeled mobile robots; and mobile manipulation. Reference Trajectory generation, feed forward control. Mobile Robots applications and case studies on aerospace, medical, chemical industry, UAV's & UGV's triage and surveillance.                                                                                                                                                                                                                                                                                                           |     |
| <b>UNIT V - APPLICATIONS OF ROBOTS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | (9) |
| Application of robotic: industrial robots, Service robots, domestic and house hold robots, Medical robots, military robots, agricultural robots, space robots, Aerial robotics Role of robots in inspection, assembly, material handling, underwater, space and healthcare. Case studies on mobile manipulator, transportation and picking areas.                                                                                                                                                                                                                                                                                                                                                                                                                       |     |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |     |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |
| 3. Modern Robotics: Mechanics, Planning, and Control, by Kevin M. Lynch , Frank C. Park , Cambridge University Press; 1st edition (25 May 2017), ISBN-10 : 110715<br>4. Modern Robotics: Mechanics, Systems and Control, by Julian Evans, Larsen and Keller Education (27 June 2019), ISBN-10 : 1641720751                                                                                                                                                                                                                                                                                                                                                                                                                                                              |     |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |     |
| 7. Modern Robotics: Designs, Systems and Control, by Jared Kroff, Willford Press (18 June 2019) ISBN-10 : 1682856763<br>8. Advanced Technologies in Modern Robotic Applications, by ChenguangYang, Hongbin Ma, Mengyin Fu, Springer; Softcover reprint of the original 1st ed. 2016 edition (30 May 2018), ISBN - 10 : 981109263X<br>9. Modern Robotics: Building Versatile Machines, by Harry Henderson, Facts On File Inc; Illustrated edition (1 August 2006), ISBN-10 : 0816057451<br>10. Artificial Intelligence for Robotics, by Francis X. Govers, Packt Publishing Limited; Standard Edition (30 August 2018), ISBN-10 : 1788835441<br>11. Modern Robotics Hardcover by Lauren Barrett (Editor), Murphy & Moore Publishing (1 March 2022), ISBN-10 : 1639873732 |     |

| Mapping of COs with POs / PSOs |          |   |          |   |          |   |          |   |   |    |          |          |   |
|--------------------------------|----------|---|----------|---|----------|---|----------|---|---|----|----------|----------|---|
| COs                            | POs      |   |          |   |          |   |          |   |   |    |          | PSOs     |   |
|                                | 1        | 2 | 3        | 4 | 5        | 6 | 7        | 8 | 9 | 10 | 11       | 1        | 2 |
| 1                              | 3        |   |          |   |          |   |          |   |   |    |          | 2        |   |
| 2                              |          |   |          |   | 2        |   |          |   |   |    |          |          |   |
| 3                              |          |   | 3        |   |          |   |          |   |   |    |          |          |   |
| 4                              |          |   |          |   |          |   |          |   |   |    | 3        |          |   |
| 5                              |          |   |          |   |          |   | 3        |   |   |    |          |          |   |
| <b>CO (W.A)</b>                | <b>3</b> |   | <b>3</b> |   | <b>2</b> |   | <b>3</b> |   |   |    | <b>3</b> | <b>2</b> |   |

| 22MEX11 - AUTOMOTIVE MATERIALS, COMPONENTS, DESIGN AND TESTING |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                              |   |   |
|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                                |                                                                                                                             | L                                                                                                                                                                                                                                                                                                                                                                                                                                       | T                                            | P | C |
|                                                                |                                                                                                                             | 2                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0                                            | 2 | 3 |
| PREREQUISITE : NIL                                             |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                              |   |   |
| Course Objective:                                              |                                                                                                                             | <ul style="list-style-type: none"><li>• To analyze and prioritize functional requirements of engine components while critically assessing suitable materials for optimal performance</li><li>• To design cylinder and piston components</li><li>• To design connecting rod and crank shaft</li><li>• To design of flywheel and valve train</li><li>• To describe the Engine Testing cycles, Emission measurement technologies</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to                 |                                                                                                                             | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                         | Weightage of COs in End Semester Examination |   |   |
| CO1                                                            | Apply engineering knowledge to identify functional requirements and select suitable materials for engine components.        | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                      | 20%                                          |   |   |
| CO2                                                            | Apply design procedures to determine dimensions of cylinder, piston, piston rings, and piston pin.                          | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                      | 20%                                          |   |   |
| CO3                                                            | Apply analytical methods to design connecting rod and crankshaft under various loads.                                       | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                      | 20%                                          |   |   |
| CO4                                                            | Apply engine component design and testing cycles to size flywheel, valve train, and evaluate performance as per standards.  | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                      | 40%                                          |   |   |
| CO5                                                            | Develop and present technical insights or case studies related to IC engine component design or emission testing practices. | C                                                                                                                                                                                                                                                                                                                                                                                                                                       | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                              |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT – I FUNCTIONAL REQUIREMENTS OF ENGINE COMPONENTS AND SUITABLE MATERIALS</b>                                                                                                                                                                                          | (6) |
| Functional requirements of engine components – Piston, piston pin, cylinder liner, connecting rod, crank shaft, valves, spring, engine block, cylinder head, and flywheel. Suitable materials for engine components.                                                         |     |
| <b>UNIT – II DESIGN OF CYLINDER AND PISTON COMPONENTS</b>                                                                                                                                                                                                                    | (6) |
| Design of cylinder, cylinder head, piston, piston rings and piston pin                                                                                                                                                                                                       |     |
| <b>UNIT – III DESIGN OF CONNECTING ROD AND CRANK SHAFT</b>                                                                                                                                                                                                                   | (6) |
| Design of connecting rod – Shank design – small end design – big end design – bolts design. Design of overhang crank shaft under bending and twisting – Crank pin design – Crank web design – Shaft design.                                                                  |     |
| <b>UNIT – IV DESIGN OF FLYWHEEL AND VALVE TRAIN</b>                                                                                                                                                                                                                          | (6) |
| Design of valve – inlet valve – exhaust valve - Valve springs – Camshafts – SOHC & DOHC– tappet – rocker arm. Determination of mass of flywheel for a given coefficient of fluctuation of speed. Design of flywheel - rim - hub – arm.                                       |     |
| <b>UNIT – V ENGINE TESTING</b>                                                                                                                                                                                                                                               | (6) |
| Engine test cycles – Worldwide harmonized Light-duty vehicles Test Cycles ((WLTC) – World Harmonized Stationary Cycle (WHSC) – World Harmonized Vehicle Cycle (WHVC) – Nonroad Transient Cycle (NRTC) – ISO 8178. Dynamometer - Chassis dynamometer - transient dynamometer. |     |

Emission measurement technologies and instruments - NO<sub>x</sub> – Smoke – Particulate matter – CO – CO<sub>2</sub> - HC.-Particle counter, Current Standards followed in India for Engine Testing.

**TOTAL (L:30 + P:30) = 60 PERIODS**

#### EXPERIMENTS

1. Design and animate Piston Cylinder assembly and motion study using CAD software.
2. Design and simulate Connecting rod and crank shaft
3. Design flywheel and valve
4. Design and simulate Two Cylinder Engine assembly using CAD software.
5. Conduct the engine performance test
6. Conduct the emission test

#### TEXT BOOKS:

1. Khurmi. R.S. & Gupta. J.K., "A text book of Machine Design", Eurasia Publishing House (Pvt) Ltd, 2001.
2. The Automotive Chassis: Volume I: Components Design (Mechanical Engineering Series) by Giancarlo Genta and Lorenzo Morello | 24 December 2019

#### REFERENCES:

1. Hiroshima Yamagata, "The science and technology of materials in automotive engines", Woodhead Publishing Limited, Cambridge, England.
2. Jain.R.K, "Machine Design", Khanna Publishers, New Delhi, 2005
3. Manufacturing Automotive Components from Sustainable Natural Fiber Composites (SpringerBriefs in Materials) by Lobna A. Elseify, Mohamad Midani, et al. | 9 August 2021
4. Mechanical and Materials Engineering of Modern Structure and Component Design (Advanced Structured Materials Book 70) by Andreas Öchsner and Holm Altenbach | 6 June 2015
5. Advanced Technology for Design and Fabrication of Composite Materials and Structures: Applications to the Automotive, Marine, Aerospace and ... Applications of Fracture Mechanics) by George C. Sih, Alberto Carpinteri, et al. | 15 December 2010

#### Mapping of COs with POs / PSOs

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 2        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 3        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 4        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 5        |     |   |   |   |   | 3 | 3 |   |   |    |    |      |   |
| CO (W.A) | 3   | 3 |   |   |   | 3 | 3 |   |   |    |    | 3    |   |

| 22MEX12 - CONVENTIONAL AND FUTURISTIC VEHICLE TECHNOLOGY |                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                                              |   |   |
|----------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                          |                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | L               | T                                            | P | C |
|                                                          |                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                                       |                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                                              |   |   |
| Course Objective:                                        |                                                                                                                                            | <ul style="list-style-type: none"><li>• To determine the number of stages/plates required</li><li>• To learn various advanced combustion technologies and its benefits</li><li>• To learn the methods of using low carbon fuels and its significance</li><li>• To analyze the advanced engine technologies</li><li>• To apply advanced principles of drivetrain technology in diverse operational scenarios</li><li>• To study the application of fuel cell technology in automotives</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to           |                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                                      | Analyze advanced combustion technologies and their effectiveness in reducing emissions and improving efficiency.                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Ap              | 20%                                          |   |   |
| CO2                                                      | Evaluate the applicability, performance, and limitations of various low-carbon and alternative fuels in internal combustion engines.       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | E               | 20%                                          |   |   |
| CO3                                                      | Apply recent advancements in engine management, turbocharging, and after-treatment systems for enhancing engine performance.               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Ap              | 20%                                          |   |   |
| CO4                                                      | Assess the performance and integration of advanced drivetrain and fuel cell technologies for modern and future mobility solutions.         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | An              | 40%                                          |   |   |
| CO5                                                      | Design and present case studies or technical solutions related to low-emission combustion, drivetrain innovations, or hydrogen fuel cells. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | U               | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                      |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT – I COMBUSTION TECHNOLOGY</b>                                                                                                                                                                                                                                                                                                                                                | (9) |
| Spark Ignition combustion, Compression Ignition Combustion, Conventional Dual Fuel Combustion, Low Temperature Combustion Concepts– Controlled Auto Ignition, Homogeneous Charge Compression Ignition, Premixed Charge Compression Ignition, Partially Premixed Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition.    |     |
| <b>UNIT – II LOW CARBON FUEL TECHNOLOGY</b>                                                                                                                                                                                                                                                                                                                                          | (9) |
| Alcohol Fuels, Ammonia Fuel and Combustion, Methane Technology, Dimethyl Ether, Hydrogen Fuel Technology, Challenges, and way forward                                                                                                                                                                                                                                                |     |
| <b>UNIT – III ADVANCED ENGINE TECHNOLOGY</b>                                                                                                                                                                                                                                                                                                                                         | (9) |
| Gasoline Direct Injection, Common Rail Direct Injection, Fixed Geometry Turbocharger, Variable Geometry Turbocharger (VGT), Variable Compression Ratio Turbocharged Engines, Electric Turbochargers, Variable valve timing (VVT), Intelligent Cylinder De-activation, After Treatment Technologies, Electric Exhaust Gas Recirculation, recent Engine Management System architecture |     |

|                                                                                                                                                                                                                                                                                                       |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT – IV ADVANCED DRIVE TRAIN TECHNOLOGY</b>                                                                                                                                                                                                                                                      | <b>(9)</b> |
| Automatic Planetary Gearbox, Torque Converter, Fluid Coupling, Continuously Variable Transmission (CVT), Automated Manual Transmission (AMT), Dual clutch transmission (DCT)/ Direct Shift Gearbox (DSG), Intelligent Manual Transmission (IMT) / Clutch-less Transmission, Limited Slip Differential |            |
| <b>UNIT – V FUEL CELL TECHNOLOGY</b>                                                                                                                                                                                                                                                                  | <b>(9)</b> |
| Fuel cells for automotive applications - Technology advances in fuel cell vehicle systems - Onboard hydrogen storage - Liquid hydrogen and compressed hydrogen - Metal hydrides, Fuel cell control system - Alkaline fuel cell - Road map to market.                                                  |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                      |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| <ol style="list-style-type: none"> <li>1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004</li> <li>2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines. ISBN 978-3-319-68507-6, SPRINGER</li> </ol>                                                                                                                                                                               |  |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| <ol style="list-style-type: none"> <li>1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.</li> <li>2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003</li> <li>3. Rand D.A.J, Woods, R &amp; Dell RM Batteries for Electric vehicles, John Wiley &amp; Sons, 1998</li> <li>4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.</li> <li>5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003</li> </ol> |  |

| <b>Mapping of COs with POs / PSOs</b> |            |          |          |          |          |          |          |          |          |           |           |             |          |
|---------------------------------------|------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-------------|----------|
| <b>COs</b>                            | <b>POs</b> |          |          |          |          |          |          |          |          |           |           | <b>PSOs</b> |          |
|                                       | <b>1</b>   | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>1</b>    | <b>2</b> |
| <b>1</b>                              | 3          |          |          |          |          |          |          |          |          |           |           | 3           |          |
| <b>2</b>                              | 3          | 3        |          |          |          |          |          |          |          |           |           | 3           |          |
| <b>3</b>                              | 3          |          |          |          |          |          |          |          |          |           |           | 3           |          |
| <b>4</b>                              | 3          | 3        |          |          |          |          |          |          |          |           |           | 3           |          |
| <b>5</b>                              |            |          |          |          |          | 3        |          |          |          |           |           |             |          |
| <b>CO (W.A)</b>                       | <b>3</b>   | <b>3</b> |          |          |          | <b>3</b> |          |          |          |           |           | <b>3</b>    |          |





## 22MEX13 - RENEWABLE POWERED OFF HIGHWAY VEHICLES AND EMISSION CONTROL TECHNOLOGY

|  |          |          |          |          |
|--|----------|----------|----------|----------|
|  | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> |
|  | <b>3</b> | <b>0</b> | <b>0</b> | <b>3</b> |

**PREREQUISITE : NIL**

|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Course Objective:</b> | <ul style="list-style-type: none"> <li>• To study the low and zero carbon fuels suitability and methods of use in off-road vehicles</li> <li>• To learn and understand the green energy production methodologies and its use in off-road vehicle categories</li> <li>• To learn various fuel cell types and its suitability in off-highway vehicles applications</li> <li>• To illustrate the impact of in-cylinder technologies on engine out emissions control</li> <li>• To study the existing after-treatment technologies used in off-highway vehicle applications</li> </ul> |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Course Outcomes<br>The Student will be able to |                                                                                                                                           | Cognitive Level | Weightage of COs in End Semester Examination |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|
| CO1                                            | Analyze the suitability and technologies of low and zero carbon fuels for powering off-road vehicles.                                     | Ap              | 20%                                          |
| CO2                                            | Apply solar and hydrogen technologies to develop green energy solutions for off-highway vehicles.                                         | Ap              | 20%                                          |
| CO3                                            | Evaluate the design and application of fuel cells for off-highway vehicle power systems.                                                  | E               | 20%                                          |
| CO4                                            | Apply the principles of after-treatment technologies in emission control for off-highway vehicles.                                        | Ap              | 40%                                          |
| CO5                                            | Apply recent developments in sustainable propulsion systems and present a case study related to low-emission off-road mobility solutions. | Ap              | Internal Assessment                          |

### UNIT – I LOW AND ZERO CARBON FUELS POWERED OFF-HIGHWAY VEHICLES

(9)

Ethanol, Methanol, Butanol, Biodiesel, Compressed natural gas, liquefied natural gas, Dimethyl ether, Polyoxymethylene Dimethyl Ether, Ammonia and Hydrogen Fuels suitability, methods, and technologies for powering off-road vehicles.

### UNIT – II GREEN ENERGY POWERED OFF-HIGHWAY VEHICLES

(9)

Solar Technology for Green Electricity, Green Electricity for Hydrogen Production, Hydrogen Smart Grid Technologies, Hydrogen to ICE powered vehicles, Hydrogen to Fuel Cell Powered Vehicles.

### UNIT – III FUEL CELL POWERED OFF-HIGHWAY VEHICLES

(9)

Fuel Cell, Types, Applications, Fuel Cell Requirement, Sizing and Design for Off-Highway applications, Merits and Demerits, Pathway to overcome the limitations. Scope of the fuel cell research on Off-road vehicle applications.

|                                                                                                                                                                                                                                              |            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT – IV IN-CYLINDER TREATMENT TECHNOLOGIES</b>                                                                                                                                                                                          | <b>(9)</b> |
| Low temperature Combustion Modes - Homogeneous Charge Compression Ignition, Premixed- Charge Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition, Water Injection Technologies. |            |
| <b>UNIT – V AFTER TREATMENT TECHNOLOGIES</b>                                                                                                                                                                                                 | <b>(9)</b> |
| Diesel Oxidation Catalyst, Diesel Particulate Filter, Selective Catalytic Reduction, Ammonia slip / clean up catalyst. CO <sub>2</sub> absorption techniques, Waste Heat Recovery and Organic Rankine Cycle.                                 |            |
| <b>TOTAL(L:45) = 45 PERIODS</b>                                                                                                                                                                                                              |            |

| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <ol style="list-style-type: none"> <li>1. John Twidell, and Tony Weir. Renewable Energy Sources – 3rd Edition 2015</li> <li>2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| <ol style="list-style-type: none"> <li>1. Daniel J Holt. Fuel Cell Powered Vehicles: Automotive Technology of the Future. Society of Automotive Engineers, 2001 - Technology &amp; Engineering,</li> <li>2. W. Addy Majewski, Magdi K. Khair. Diesel Emissions and Their Control.</li> <li>3. Toward Zero Carbon: The Chicago Central Area DeCarbonization Plan by Adrian Smith and Gordon Gill   1 June 2011</li> <li>4. Transportation in a Net Zero World: Transitioning Towards Low Carbon Public Transport (Green Energy and Technology) by Kathryn G. Logan, Astley Hastings, et al.   7 April 2022</li> <li>5. The Political Economy of Low Carbon Transformation: Breaking the habits of capitalism (Routledge Studies in Low Carbon Development) by Harold Wilhite   21 December 2017</li> </ol> |  |

| <b>Mapping of COs with POs / PSOs</b> |            |          |          |          |          |          |          |          |          |           |           |             |          |
|---------------------------------------|------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-------------|----------|
| <b>COs</b>                            | <b>POs</b> |          |          |          |          |          |          |          |          |           |           | <b>PSOs</b> |          |
|                                       | <b>1</b>   | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>1</b>    | <b>2</b> |
| <b>1</b>                              | 3          |          |          |          |          |          |          |          |          |           |           | 3           |          |
| <b>2</b>                              | 3          |          |          |          |          |          |          |          |          |           |           | 3           |          |
| <b>3</b>                              |            |          | 3        |          |          |          |          |          |          |           |           | 3           |          |
| <b>4</b>                              | 3          |          |          |          |          |          |          |          |          |           |           | 3           |          |
| <b>5</b>                              | 3          |          |          |          |          | 3        |          |          |          |           |           | 3           |          |
| <b>CO (W.A)</b>                       | 3          |          | 3        |          |          | 3        |          |          |          |           |           | 3           |          |

| 22MEX14 - VEHICLE HEALTH MONITORING, MAINTENANCE AND SAFETY |                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                              |   |   |
|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                             |                                                                                                                                         | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | T                                            | P | C |
|                                                             |                                                                                                                                         | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 0                                            | 0 | 3 |
| PREREQUISITE :NIL                                           |                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                              |   |   |
| Course Objective:                                           |                                                                                                                                         | <ul style="list-style-type: none"><li>To learn the fundamentals of vehicle maintenance, including diagnostics, service intervals, and international safety standards</li><li>To acquire knowledge on vehicle maintenance principles and advanced diagnostic technologies to service powertrain and vehicle systems.</li><li>To analyze the stresses acting on the temporary and permanent joints</li><li>To apply machine learning techniques to improve electronic fuel injection and engine management systems</li><li>To study and understand the simulation of safety concepts</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to              |                                                                                                                                         | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Weightage of COs in End Semester Examination |   |   |
| CO1                                                         | Apply knowledge of vehicle maintenance principles and advanced diagnostic technologies to service powertrain and vehicle systems        | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 40%                                          |   |   |
| CO2                                                         | Analyze and implement maintenance strategies for vehicle systems, including powertrain components and vehicle systems                   | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 20%                                          |   |   |
| CO3                                                         | Apply knowledge of active and passive safety systems to enhance vehicle safety features and meet regulatory requirements.               | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 20%                                          |   |   |
| CO4                                                         | Apply simulation methods to analyze, evaluate, and improve vehicle safety performance under various operating and collision conditions. | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 20%                                          |   |   |
| CO5                                                         | Implement maintenance practices for ensuring optimal vehicle handling and safety                                                        | U                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>UNIT – I INTRODUCTION</b>                                                                                                                                                                                                                                                                                                                                                                                                           | <b>9</b> |
| `Need for maintenance – importance, classification of maintenance work-basic problem diagnosis. maintenance of vehicle systems – power pack, tyres, safety systems. scheduled maintenance services – service intervals – on-board diagnostics, computerized engine analyzer study and practice- obd and scan tools; Importance of advanced diagnostic technologies, Overview of international vehicle safety standards and regulations |          |
| <b>UNIT – II POWERTRAIN MAINTENANCE</b>                                                                                                                                                                                                                                                                                                                                                                                                | <b>9</b> |
| Exhaust emission test of petrol and diesel engine; - Electronic fuel injection and engine management service - fault diagnosis- OBD-III and scan tool, identifying DTC and servicing emission controls, Maintenance of Batteries, Starting System, Charging System and Body Electrical - Application of Machine Learning in Electronic Fuel Injection and Engine Management Service.                                                   |          |
| <b>UNIT – III VEHICLE SYSTEM MAINTENANCE</b>                                                                                                                                                                                                                                                                                                                                                                                           | <b>9</b> |
| Clutch- adjustment and service, Maintenance and Service of Hydraulic brake, Bleeding of brakes, Checking ABS and components. Maintenance and Service of McPherson strut, coil spring. tyre wear, measurement of read depth and tyre rotation, Smart tyre wear monitoring and management systems Computerized wheel balancing & wheel alignment, Maintenance and Service of steering linkage, steering column, Rack and pinion steering |          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                 |          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| <b>UNIT – IV VEHICLE SAFETY</b>                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>9</b> |
| Concepts of vehicle safety -Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, air bags, electronic system for activating air bags, bumper design for safety, Active Safety - ABS, EBD, CSC, Traction control system, Modern electronic features in vehicles like tyre pressure monitoring, Automatic headlamp ON, Rain sensing wipers. Cybersecurity measures for vehicle safety and data protection   |          |
| <b>UNIT – V SIMULATION OF SAFETY CONCEPTS</b>                                                                                                                                                                                                                                                                                                                                                                                                   | <b>9</b> |
| Active safety: driving safety, conditional safety, perceptibility safety, operating safety passive safety: exterior safety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact. Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system Interactions. |          |
| <b>TOTAL 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                         |          |

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOK:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <ol style="list-style-type: none"> <li>5th Edition, “Advanced Automotive Fault Diagnosis Automotive Technology: Vehicle Maintenance and Repair” By Tom Denton</li> <li>Safety Management System and Documentation Training Programme Handbook by S. V. Paul ISBN: 9788123923444</li> </ol>                                                                                                                                                                                                            |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <ol style="list-style-type: none"> <li>Ed May, "Automotive Mechanics Volume One" and Two, Mc Graw Hill Publications, Tenth edition, 2018</li> <li>Bosch Automotive Handbook, Tenth Edition, 2018</li> <li>Jack Erjavek, “A systems approach to Automotive Technology”, Cengage Learning, 5th Edition, 2012</li> <li>William H. Crouse and Donald L. Anglin, “Automotive Mechanics”, Tata McGraw Hill, 10th Edition, 2004.</li> <li>Vehicle Service Manuals of Reputed Indian Manufacturers</li> </ol> |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    | 2    |   |
| 2                              |     | 3 |   |   |   |   |   |   |   |    |    | 3    |   |
| 3                              | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 4                              | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 5                              |     |   |   |   |   | 2 | 2 |   |   |    | 2  |      | 2 |
| CO (W.A)                       | 3   | 3 |   |   |   | 2 | 2 |   |   |    | 2  | 3    | 2 |

| 22MEX15 - CAE AND CFD APPROACH IN FUTURE MOBILITY |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                                              |   |   |
|---------------------------------------------------|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                   |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                       | L               | T                                            | P | C |
|                                                   |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                       | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                                |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |                                              |   |   |
| Course Objective:                                 |                                                                                            | <ul style="list-style-type: none"><li>• To study the use of computer in mobility software or mobility.</li><li>• To study the concepts computer aided design and rapid prototyping</li><li>• To introduce the basic concepts of the finite elements methods.</li><li>• To introduce basics and fundamental of the computational fluid dynamics</li><li>• To introduce Turbulence Modeling and various simulation techniques</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to    |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                       | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                               | Apply the concepts of computational fluid dynamics in mobility engineering.                |                                                                                                                                                                                                                                                                                                                                                                                                                                       | Ap              | 20%                                          |   |   |
| CO2                                               | Apply the modeling and discretization technique in various mechanical elements.            |                                                                                                                                                                                                                                                                                                                                                                                                                                       | Ap              | 20%                                          |   |   |
| CO3                                               | Analyze the durability, reliability and crash analysis                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                       | An              | 20%                                          |   |   |
| CO4                                               | Analyze the basic concept of the Computer Aided Engineering / Computational Fluid Dynamics |                                                                                                                                                                                                                                                                                                                                                                                                                                       | An              | 40%                                          |   |   |
| CO5                                               | Develop the computer aided design and model in rapid prototyping.                          |                                                                                                                                                                                                                                                                                                                                                                                                                                       | Ap              | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |
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| <b>UNIT I - COMPUTER AIDED ENGINEERING AND COMPUTATIONAL FLUID DYNAMICS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | (9) |
| Introduction to use of computer in Mobility Product Life Cycle, Software for mobility. Introduction to design process and role of computers in the design process, use of modern computational tools used for design and analysis, Concept of modeling and simulation. CFD as a design and research tool, Applications of CFD in mobility engineering                                                                                                                                                                                       |     |
| <b>UNIT II - APPLICATIONS OF COMPUTER AIDED ENGINEERING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | (9) |
| Computational Fluid Dynamics – Introduction three dimensional of fluid dynamics, equilibrium equation for a fluid conversation. Injection moulding of plastics simplification of mould geometry for FEA material model. Simulation for manufacturing process like casting and sheet metal applications. Durability analysis, reliability, crash analysis. Noise vibration and hardness NVH analysis.                                                                                                                                        |     |
| <b>UNIT III - FINITE ELEMENT ANALYSIS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | (9) |
| Basic Concept of Finite Element Method, Ritz and Rayleigh Ritz methods, Method of weighed residuals, Galerkin method. Governing differential equations of one and two dimensional problems, One Dimensional Second Order Equations – Discretization – Linear and Higher order Elements – Interpolation and shape functions, Derivation of Shape functions and Stiffness matrices and force vectors-Assembly of Matrices - Solution of static problems and case studies in stress analysis of mechanical components using 2D and 3D elements |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |
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| <b>UNIT IV - COMPUTATIONAL FLUID DYNAMICS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>(9)</b> |
| CFD vs. experimentation; continuity, Navier-stokes and energy equations; modeling and discretization techniques; basic steps in CFD computation various simplifications, Dimensionless equations and parameters, Incompressible inviscid flows, Source panel method, and Vortex panel method. Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching. 3-D structured and unstructured grid generation, mesh smoothing and sensitivity checks. Different types of codes and grids used for CFD calculations. |            |
| <b>UNIT V - PROBLEM SOLVING USING CFD</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Turbulence Modeling, different turbulent modeling scheme. Incompressible Viscous Flows, Applications to internal flows and boundary layer flows. Eddy viscosity and non-eddy viscosity models; Vehicle Aerodynamic Simulation Wind tunnel and on-road simulation of vehicles; Simulation of Ahmed and Windsor bodies; Vorticity based grid-free simulation technique; simulation in climatic and acoustic wind tunnels; velocity vector and pressure contour simulation                                                                                      |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <ol style="list-style-type: none"> <li>1. Computational Fluid Dynamics: A Practical Approach by Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu, Butterworth – Heinemann Ltd, Second Edition, 2012.</li> <li>2. Applied Computational Fluid Dynamics by S. C. Gupta, Wiley publisher, 2019</li> </ol>                                                                                                                                                                                                                                                                                                                                                                           |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <ol style="list-style-type: none"> <li>1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co. 2007</li> <li>2. Groover, M. P., CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, 2008</li> <li>3. Tirupathi R. Chandrupatla and Ashok D. Belegundu, “Introduction to Finite Elements in Engineering”, International Edition, Pearson Education Limited, 2014.</li> <li>4. Dhanaraj. R and Prabhakaran Nair. K, “Finite Element Analysis”, Oxford Publications, 2015.</li> <li>5. Versteeg, H.K., and Malalasekera, W., “An Introduction to Computational Fluid Dynamics”: The finite volume Method, Pearson Education, 2014</li> </ol> |

| <b>Mapping of COs with POs / PSOs</b> |            |          |          |          |          |          |          |          |          |           |           |             |          |
|---------------------------------------|------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-------------|----------|
| <b>COs</b>                            | <b>POs</b> |          |          |          |          |          |          |          |          |           |           | <b>PSOs</b> |          |
|                                       | <b>1</b>   | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>1</b>    | <b>2</b> |
| <b>1</b>                              | 2          |          |          |          |          |          |          |          |          |           |           |             |          |
| <b>2</b>                              | 2          |          |          |          |          |          |          |          |          |           |           |             |          |
| <b>3</b>                              |            | 1        |          |          |          |          |          |          |          |           |           |             | 1        |
| <b>4</b>                              |            | 1        |          |          |          |          |          |          |          |           |           |             | 1        |
| <b>5</b>                              |            |          |          |          |          | 1        |          |          |          |           |           |             |          |
| <b>CO (W.A)</b>                       | 2          | 1        |          |          |          | 1        |          |          |          |           |           |             | 1        |

| 22MEX16 - HYBRID AND ELECTRIC VEHICLE TECHNOLOGY |                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              |   |   |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                  |                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              | L | T |
|                                                  |                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              | P | C |
|                                                  |                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              | 3 | 0 |
| PREREQUISITE : NIL                               |                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                              |   |   |
| Course Objective:                                |                                                                                                                                         | <ul style="list-style-type: none"><li>• To introduce the concept of hybrid and electric drive trains.</li><li>• To elaborate on the types and utilization of hybrid and electric drive trains.</li><li>• To expose on different types of AC and DC drives for electric vehicles.</li><li>• To learn and utilize different types of energy storage systems</li><li>• To introduce concept of energy management strategies and drive sizing</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to   |                                                                                                                                         | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                     | Weightage of COs in End Semester Examination |   |   |
| CO1                                              | Apply the performance and power source characterization of hybrid and electric vehicles in relation to their impact on energy supplies. | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 20%                                          |   |   |
| CO2                                              | Apply power flow control techniques to optimize fuel efficiency in hybrid and electric drive-train topologies.                          | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 20%                                          |   |   |
| CO3                                              | Implement and control AC and DC motor drives in hybrid and electric vehicles to enhance drive system efficiency.                        | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 20%                                          |   |   |
| CO4                                              | Analyze the performance and hybridization of different energy storage devices in hybrid and electric vehicles.                          | An                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 40%                                          |   |   |
| CO5                                              | Explain the historical development, social, and environmental significance of hybrid and electric vehicles.                             | U                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Internal Assessment                          |   |   |

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| <b>UNIT I : INTRODUCTION TO HYBRID AND ELECTRIC VEHICLES</b>                                                                                                                                                                                                                                                                                                                 | (9) |
| Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.                                                                                                          |     |
| <b>UNIT II : HYBRID ELECTRIC DRIVE TRAINS</b>                                                                                                                                                                                                                                                                                                                                | (9) |
| Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. |     |
| <b>UNIT III : CONTROL OF AC &amp; DC DRIVES</b>                                                                                                                                                                                                                                                                                                                              | (9) |
| Introduction to electric components used in hybrid and electric vehicles, Configuration, and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency.                                                                                                                                   |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                         |     |
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| <b>UNIT IV : ENERGY STORAGE</b>                                                                                                                                                                                                                                                                                                                                                                                         | (9) |
| Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage and its analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of different energy storage devices                                                                                                                                                                                             |     |
| <b>UNIT V : DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES</b>                                                                                                                                                                                                                                                                                                                                                           | (9) |
| Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification, and comparison of energy management strategies, Implementation issues. |     |
| <b>TOTAL(L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                         |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <ol style="list-style-type: none"> <li>1. Iqbal Husain, Electric and Hybrid Vehicles : Design Fundamentals, 3rd edition, 2021</li> <li>2. James Larminie, John Lowry, Electric Vehicle Technology, Wiley, 2003</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <ol style="list-style-type: none"> <li>1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004</li> <li>2. D.A.J. Rand, R. Woods, R.M. Dell. Batteries for Electric vehicles, John Wiley &amp; Sons, 1998</li> <li>3. Jack Erjavec , Hybrid, Electric and Fuel-Cell Vehicles, International Edition, 2012</li> <li>4. Christian Paar, Energy Management in Hybrid Electric Vehicles using Co-Simulation, 2011</li> <li>5. YangshengXu, Jingyu Yan, Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids, 2013</li> </ol> |

| Mapping of COs with POs / PSOs |          |          |   |   |   |          |   |   |   |    |    |          |   |
|--------------------------------|----------|----------|---|---|---|----------|---|---|---|----|----|----------|---|
| COs                            | POs      |          |   |   |   |          |   |   |   |    |    | PSOs     |   |
|                                | 1        | 2        | 3 | 4 | 5 | 6        | 7 | 8 | 9 | 10 | 11 | 1        | 2 |
| 1                              | 3        | 3        |   |   |   |          |   |   |   |    |    | 3        |   |
| 2                              | 3        |          |   |   |   |          |   |   |   |    |    | 3        |   |
| 3                              | 3        |          |   |   |   |          |   |   |   |    |    | 3        |   |
| 4                              | 3        | 3        |   |   |   |          |   |   |   |    |    | 3        |   |
| 5                              |          |          |   |   |   | 3        |   |   |   |    |    |          |   |
| <b>CO (W.A)</b>                | <b>3</b> | <b>3</b> |   |   |   | <b>3</b> |   |   |   |    |    | <b>3</b> |   |



| 22MEX17 - THERMAL MANAGEMENT OF BATTERIES AND FUEL CELLS |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                        |                                                     |          |
|----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>L</b>               | <b>T</b>                                            | <b>P</b> |
|                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>3</b>               | <b>0</b>                                            | <b>0</b> |
| <b>PREREQUISITE : 22CHC09</b>                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                        |                                                     |          |
| <b>Course Objective:</b>                                 | <ul style="list-style-type: none"> <li>To study the working principle of Li-ion Batteries and Battery Packs.</li> <li>To learn the thermal management system in Battery modules.</li> <li>To develop the different case studies in Battery Thermal Management System.</li> <li>To learn the working principle of Fuel Cells and cooling methods.</li> <li>To learn the inside components of Thermal Management Systems in various famous Electric and Fuel Cell Electric Vehicles.</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                      | Apply knowledge of Li-ion battery chemistry, formats, and management systems to optimize battery performance and longevity.                                                                                                                                                                                                                                                                                                                                                                   | Ap                     | 20%                                                 |          |
| CO2                                                      | Apply thermal management techniques to optimize battery performance in electric vehicles.                                                                                                                                                                                                                                                                                                                                                                                                     | Ap                     | 20%                                                 |          |
| CO3                                                      | Analyze EV battery cooling challenges, PCM-based heat exchanger design, Chevrolet Volt thermal management, and liquid cooling simulations using COMSOL.                                                                                                                                                                                                                                                                                                                                       | An                     | 20%                                                 |          |
| CO4                                                      | Analyze the thermal management requirements and solutions for fuel cell systems in electric vehicles.                                                                                                                                                                                                                                                                                                                                                                                         | An                     | 40%                                                 |          |
| CO5                                                      | Demonstrate the configuration and characteristics of battery management systems in advanced batteries.                                                                                                                                                                                                                                                                                                                                                                                        | U                      | Internal Assessment                                 |          |

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT I : ADVANCED BATTERIES</b>                                                                                                                                                                                                                                                                                            | (9) |
| Li-ion Batteries- chemistry, different formats, operating areas, efficiency, aging. Battery Management System- Configuration, Characteristics. Tesla Model S-18650 Cell specifications, P85 Battery Pack mechanical structure, Texas Instruments BMS. Super capacitors Vs batteries. Diamond battery concepts.                |     |
| <b>UNIT II : THERMAL MANAGEMENT IN BATTERIES</b>                                                                                                                                                                                                                                                                              | (9) |
| Thermal Management Systems- impact, Types- Air, Liquid, Direct refrigerant, Heat pipe, Thermo Electric, Phase Change Material (PCM) Cooling methods. Solid-liquid PCM Types- Organic, Inorganic, Eutectics. PCM Thermal properties and applications. Tesla Model-S Battery Module- bonding techniques, thermal management.    |     |
| <b>UNIT III : BATTERY THERMAL MANAGEMENT CASE STUDIES</b>                                                                                                                                                                                                                                                                     | (9) |
| EV Battery Cooling- challenges and solutions. Heat Exchanger Design and Optimization Model for EV Batteries using PCMs- system set up, selection of PCMs. Chevrolet Volt Model Battery Thermal Management System- Case study. Modeling Liquid Cooling of a Li-Ion Battery Pack with COMSOL Multi physics- simulation concepts |     |

|                                                                                                                                                                                                                                                                                                                                                      |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT IV : THERMAL MANAGEMENT IN FUEL CELLS</b>                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Fuel Cells- operating principle, hydrogen-air fuel cell system characteristics, other fuel cell technologies, polarization curves, applications. Fuel cell thermal management- basic model, energy balance, governing equations, characteristic curve, sizing, cooling methods, advantages, restrictions.                                            |            |
| <b>UNIT V : FUEL CELL THERMAL MANAGEMENT CASE STUDIES</b>                                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Fuel cell system- balance of plant- components required. Fuel cell power plant sizing problems- Fuel Cell Electric Vehicle Fuel economy calculations-Battery EVs Vs Fuel Cell EVs. Toyota Mirai FCV- Operating principle, High pressure hydrogen tank, Boost convertor, NiMH Battery, Internal circulation system, Hydrogen refueling- Case studies. |            |
| <b>TOTAL(L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                      |            |

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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
| <ol style="list-style-type: none"> <li>1. Ibrahim Dincer, Halil S. Hamut, and Nader Javani, "Thermal Management of Electric Vehicle Battery Systems", Wiley, 2017.</li> <li>2. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles", Wiley, 2015.</li> <li>3. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles-Fundamentals, Theory, and Design", CRC Press, 2005.</li> <li>4. John G. Hayes and G. Abas Goodarzi, "Electric Powertrain", Wiley, 2018</li> <li>5. Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.</li> </ol> |  |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
| <ol style="list-style-type: none"> <li>1. Nag.P.K, "Engineering Thermodynamics", 5th Edition, Tata McGraw Hill Education, New Delhi, 2013.</li> <li>2. "Vehicle thermal Management Systems Conference Proceedings", 1st Edition; 2013, Coventry Techno centre, UK</li> <li>3. Younes Shabany," Heat Transfer: Thermal Management of Electronics Hardcover" 2010, CRC Press.</li> <li>4. T. Yomi Obidi, "Thermal Management in Automotive applications", 2015, SAE International.</li> <li>5. Jerry Sergeant, Al Krum, "Thermal Management Handbook: For Electronic Assemblies Hardcover", 1998, Mc Graw-Hill</li> </ol>                                                                                              |  |

| <b>Mapping of COs with POs / PSOs</b> |            |          |          |          |          |          |          |          |          |           |           |             |          |
|---------------------------------------|------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-------------|----------|
| <b>COs</b>                            | <b>POs</b> |          |          |          |          |          |          |          |          |           |           | <b>PSOs</b> |          |
|                                       | <b>1</b>   | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>1</b>    | <b>2</b> |
| <b>1</b>                              | 3          |          |          |          |          |          |          |          |          |           |           | 3           |          |
| <b>2</b>                              | 3          |          |          |          |          |          |          |          |          |           |           | 3           |          |
| <b>3</b>                              | 3          | 3        |          |          |          |          |          |          |          |           |           | 3           |          |
| <b>4</b>                              | 3          | 3        |          |          |          |          |          |          |          |           |           | 3           |          |
| <b>5</b>                              |            |          |          |          |          | 3        |          |          |          |           |           |             |          |
| <b>CO (W.A)</b>                       | <b>3</b>   | <b>3</b> |          |          |          | <b>3</b> |          |          |          |           |           | <b>3</b>    |          |

| 22MEX18 - SMART MOBILITY AND INTELLIGENT VEHICLES |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                                              |   |   |
|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | L               | T                                            | P | C |
|                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                                              |   |   |
| Course Objective:                                 | <ul style="list-style-type: none"><li>• To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles</li><li>• To learn basics of radar technology and systems, ultrasonic sonar systems, LIDAR sensor technology and systems and other sensors for automobile vision system</li><li>• To learn basic control system theory applied to autonomous automobiles</li><li>• To produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task</li><li>• To allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car &amp; autonomous vehicle technology.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                               | Apply knowledge of automotive electronics and systems to understand and implement concepts of automated, connected, and intelligent vehicles through case study analysis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Ap              | 20%                                          |   |   |
| CO2                                               | Apply radar, ultrasonic, lidar, camera, and night vision sensor technologies along with sensor data fusion techniques for integration into smart mobility control systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Ap              | 20%                                          |   |   |
| CO3                                               | Apply concepts of autonomous vehicle control, sensing, and ECU operation alongside wireless communication, networking, and IoT integration for connected autonomous vehicle systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Ap              | 40%                                          |   |   |
| CO4                                               | Apply connected car technologies, including V2V, V2I communications, navigation, and autonomous vehicle systems while evaluating associated legal, ethical, and security challenges.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Ap              | 20%                                          |   |   |
| CO5                                               | Demonstrate the ability to research, present, and critically discuss recent advancements and technologies in automated, connected, and autonomous vehicles.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | U               | Internal Assessment                          |   |   |

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I- INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES</b>                                                                                                                                                                                                       | <b>(9)</b> |
| Concept of automotive electronics, electronics overview, history & evolution, infotainment, body, chassis, and powertrain electronics, introduction to automated, connected, and intelligent vehicles. case studies: automated, connected, and intelligent vehicles.                |            |
| <b>UNIT II - SENSOR TECHNOLOGY FOR SMART MOBILITY</b>                                                                                                                                                                                                                               | <b>(9)</b> |
| Basics of radar technology and systems, ultrasonic sonar systems, lidar sensor technology and systems, camera technology, night vision technology, other sensors, use of sensor data fusion, integration of sensor data to on-board control systems.                                |            |
| <b>UNIT III - CONNECTED AUTONOMOUS VEHICLE</b>                                                                                                                                                                                                                                      | <b>(9)</b> |
| Concepts of autonomous vehicles, basic control system theory applied to automobiles, overview of the operation of ECUs, basic cyber-physical system theory and autonomous vehicles, role of surroundings sensing systems and autonomy, role of wireless data networks and autonomy. |            |

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| <b>UNIT IV - VEHICLE WIRELESS TECHNOLOGY &amp; NETWORKING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Wireless system block diagram and overview of components, transmission systems – modulation/encoding, receiver system concepts– demodulation/decoding, wireless networking and applications to vehicle autonomy, basics of computer networking – the internet of things, wireless networking fundamentals, integration of wireless networking and on-board vehicle networks.                                                                                                                                                                                                             |            |
| <b>UNIT V – CONNECTED CAR &amp; AUTONOMOUS VEHICLE TECHNOLOGY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>(9)</b> |
| Connectivity fundamentals, navigation and other applications, vehicle-to-vehicle technology and applications, vehicle-to-roadside and vehicle-to-infrastructure applications, autonomous vehicles - driverless car technology, moral, legal, roadblock issues, technical issues, security issues.                                                                                                                                                                                                                                                                                        |            |
| <b>TEXT BOOKS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            |
| 1. “Intelligent Transportation Systems and Connected and Automated Vehicles”, 2016, Transportation Research Board<br>2. Radovan miucic, “Connected Vehicles: Intelligent Transportation Systems”, 2019, Springer                                                                                                                                                                                                                                                                                                                                                                         |            |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |
| 1. Tom Denton, Automobile Electrical and Electronic Systems, Routledge, Taylor & Francis Group, 5th Edition, 2018.<br>2. Ronald K. Jurgen, Autonomous Vehicles: Opportunities, Strategies, and Disruptions, SAE International, 1st Edition, 2019.<br>3. Rajesh Rajamani, Vehicle Dynamics and Control, Springer, 2nd Edition, 2012.<br>4. Uwe Dieter Hanebeck, Intelligent Vehicles: Concepts, Systems and Technologies, Springer, 1st Edition, 2021.<br>5. William B. Ribbens, Understanding Automotive Electronics, Butterworth-Heinemann (An Imprint of Elsevier), 8th Edition, 2017. |            |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 2                              |     | 3 |   |   |   |   |   |   |   |    |    | 1    |   |
| 3                              | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 4                              | 3   |   |   |   |   |   |   |   |   |    |    | 1    |   |
| 5                              |     |   |   |   |   |   |   |   | 2 |    | 2  |      |   |
| CO (W.A)                       | 3   | 3 |   |   |   |   |   |   | 2 |    | 2  | 1    |   |

| 22MEX2I - TURBO MACHINES                       |                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                              |   |   |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                |                                                                                                                   | L                                                                                                                                                                                                                                                                                                                                                                                                                                                             | T                                            | P | C |
|                                                |                                                                                                                   | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| Course Objective:                              |                                                                                                                   | <ul style="list-style-type: none"><li>• To study the energy transfer in rotor and stator parts of the turbo machines.</li><li>• To study the function of various elements of centrifugal fans and blowers.</li><li>• To evaluating the working and performance of centrifugal compressor</li><li>• To analyzing flow behavior and flow losses in axial flow compressor.</li><li>• To study the types and working of axial and radial flow turbines.</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                   | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                               | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply the principles of energy transfer in rotor and stator parts of turbomachines.                               | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 20 %                                         |   |   |
| CO2                                            | Analyze the flow behavior and flow losses in axial flow compressors.                                              | An                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 20 %                                         |   |   |
| CO3                                            | Evaluate the working and performance of centrifugal compressors an axial and radial flow turbines.                | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 40 %                                         |   |   |
| CO4                                            | Justify the functions of various elements in centrifugal fans and blowers.                                        | Ap/C                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 20 %                                         |   |   |
| CO5                                            | Develop teamwork and collaboration skills through group-based on the turbo machines assignments and peer reviews. | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Internal Assessment                          |   |   |

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| <b>UNIT I - WORKING PRINCIPLES</b>                                                                                                                                                                                                                                                                                      | <b>(9)</b> |
| Classification of Turbo machines. Energy transfer between fluid and rotor - Euler equation and its interpretation. Velocity triangles. Efficiencies in Compressor and Turbine stages. Degree of reaction. Dimensionless parameters for Turbo machines.                                                                  |            |
| <b>UNIT II - CENTRIFUGAL FANS AND BLOWERS</b>                                                                                                                                                                                                                                                                           | <b>(9)</b> |
| Types – components – working. Flow analysis in impeller blades-volute and diffusers. Velocity triangles - h-s diagram. Stage parameters in fans and blowers. Performance characteristic curves – various losses. Fan –bearings, drives and noise.                                                                       |            |
| <b>UNIT III - CENTRIFUGAL COMPRESSOR</b>                                                                                                                                                                                                                                                                                | <b>(9)</b> |
| Components - blade types. Velocity triangles - h-s diagram, stage work. Slip factor and Degree of Reaction. Performance characteristics and various losses. Geometry and performance calculation.                                                                                                                       |            |
| <b>UNIT IV - AXIAL FLOW COMPRESSOR</b>                                                                                                                                                                                                                                                                                  | <b>(9)</b> |
| Construction details. Work done factor. Velocity triangles - h-s diagram, stage work. Work done factor. Performance characteristics, efficiency and stage losses – Stalling and Surging. Free and Forced vortex flow.                                                                                                   |            |
| <b>UNIT V – AXIAL AND RADIAL FLOW TURBINES</b>                                                                                                                                                                                                                                                                          | <b>(9)</b> |
| Axial flow turbines - Types – Elements - Stage velocity diagrams - h-s diagram, stage work - impulse and reaction stages. Compounding of turbines. Performance coefficients and losses. Radial flow turbines: Types – Elements - Stage velocity diagrams - h-s diagram, stage work Performance coefficients and losses. |            |
| <b>TOTAL(L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                         |            |

**TEXT BOOKS:**

1. Ganesan, V., "Gas Turbines", 3rd Edition, Tata McGraw Hill, 2011. .
2. Yahya, S.M., "Turbines, Compressor and Fans", 4th Edition, Tata McGraw Hill, 2011.

**REFERENCES:**

1. Dixon, S.L., "Fluid Mechanics and Thermodynamics of Turbomachinery", 7th Edition, ButterworthHeinemann, 2014.
2. Gopalakrishnan. G and Prithvi Raj. D," A Treatise on Turbomachines", Scitech Publications (India) Pvt. Ltd., 2nd Edition, 2008.
3. Lewis, R.I., "Turbomachinery Performance Analysis" 1st Edition, Arnold Publisher, 1996.
4. Saravanamutto, Rogers, Cohen, Straznicky., "Gas Turbine Theory" 6th Edition, Pearson Education Ltd, 2009.
5. Venkanna, B.K., "Fundamentals of Turbomachinery", PHI Learning Pvt. Ltd., 2009.

**Mapping of COs with POs / PSOs**

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 2        |     | 3 |   |   |   |   |   |   |   |    |    | 3    |   |
| 3        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 4        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 5        | 3   |   |   |   |   |   |   | 1 | 1 |    |    | 3    |   |
| CO (W.A) | 3   | 3 |   |   |   |   |   | 1 | 1 |    |    | 3    |   |



| 22MEX22 - ADVANCED INTERNAL COMBUSTION ENGINEERING |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                                              |   |   |
|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | L               | T                                            | P | C |
|                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                 |                                              |   |   |
| Course Objective:                                  | <ul style="list-style-type: none"><li>• To study the working of Gasoline fuel `injection systems and SI combustion.</li><li>• To study the working of Diesel fuel injection systems and CI combustion</li><li>• To Identifying the source and measure it; explain the mechanism of emission formation and control methods.</li><li>• To study the Selecting alternative fuel resources and its utilization techniques in IC engines.</li><li>• To study the advanced combustion modes and future power train systems.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                                | Apply the principles of combustion and fuel injection to analyze performance issues in spark ignition engines.                                                                                                                                                                                                                                                                                                                                                                                                                  | Ap              | 20%                                          |   |   |
| CO2                                                | Analyze fuel spray characteristics, combustion stages, and turbocharging techniques in compression ignition engines.                                                                                                                                                                                                                                                                                                                                                                                                            | An              | 20%                                          |   |   |
| CO3                                                | Evaluate engine emission characteristics and propose effective emission control techniques.                                                                                                                                                                                                                                                                                                                                                                                                                                     | E               | 20%                                          |   |   |
| CO4                                                | Assess the suitability and performance of alternative fuels and advanced powertrain systems for sustainable engine design.                                                                                                                                                                                                                                                                                                                                                                                                      | E               | 40%                                          |   |   |
| CO5                                                | Present technical insights on emerging combustion technologies or alternative fuels using appropriate communication methods.                                                                                                                                                                                                                                                                                                                                                                                                    | C               | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                             |     |
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| <b>UNIT I - SPARK IGNITION ENGINES</b>                                                                                                                                                                                                                                                                                                                                                                      | (9) |
| Mixture requirements – Fuel injection systems – Mono-point, Multipoint & Direct injection -Stages of combustion – Normal and Abnormal combustion, Spark Knock, Factors affecting knock, Combustion chambers.                                                                                                                                                                                                |     |
| <b>UNIT II - COMPRESSION IGNITION ENGINES</b>                                                                                                                                                                                                                                                                                                                                                               | (9) |
| Diesel Fuel Injection Systems – Mechanical and Common Rail Direct Injection Systems - Stages of combustion – Knocking – Factors affecting knock –Direct and Indirect injection systems –Fuel Spray behaviour – Spray structure and spray penetration – Air motion - Combustion chambers – Turbo charging – Waste Gate, Variable Geometry turbochargers.                                                     |     |
| <b>UNIT III - EMISSION FORMATION AND CONTROL</b>                                                                                                                                                                                                                                                                                                                                                            | (9) |
| Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling emissions – In-cylinder treatments – After treatment systems – Three Way Catalytic converter, Selective Catalytic Reduction, De-NOx Catalyst, Diesel Oxidation Catalyst and Particulate Traps – Methods of emission measurement – Emission norms and Driving cycles. |     |

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| <b>UNIT IV - ALTERNATIVE FUELS</b>                                                                                                                                                                                                          | (9) |
| Alcohol Fuels, Hydrogen – production, storage - Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel - Properties, Suitability, Merits and Demerits – Utilization Methods - Engine Modifications.                                 |     |
| <b>UNIT V - ALTERNATE COMBUSTION AND POWER TRAIN SYSTEM</b>                                                                                                                                                                                 | (9) |
| Low Temperature Combustion - Homogeneous charge compression ignition (HCCI) – Reactivity Controlled Compression Ignition (RCCI) – Gasoline Compression Ignition – Spark Assisted HCCI - Hybrid Electric and Electric Vehicles – Fuel Cells. |     |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                            |     |

|                                                                                                                                 |
|---------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                              |
| 1. V. Ganesan, “Internal Combustion Engines”, V Edition, Tata McGraw Hill, 2012.                                                |
| 2. John B. Heywood, “Internal Combustion Engines Fundamentals”, McGraw-Hill, 2009.                                              |
| <b>REFERENCES:</b>                                                                                                              |
| 1. B.P. Pundir, “IC Engines Combustion & Emission”, Narosa Publishing House, 2014.                                              |
| 2. Duffy Smith, “Auto Fuel Systems”, The Good Heart Wilcox Company, Inc., 2003.                                                 |
| 3. EranSher, Handbook of Air Pollution from Internal Combustion Engines: Pollutant Formation and Control, Academic Press, 1998. |
| 4. K.K. Ramalingam, “Internal Combustion Engine Fundamentals”, SciTech Publications, 2011.                                      |
| 5. R.B. Mathur and R.P. Sharma, “Internal Combustion Engines”, Dhanpat Rai& Sons, 2007                                          |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 2   |   |   |   |   |   |   |   |   |    |    | 1    |   |
| 2                              | 2   |   |   |   |   |   |   |   |   |    |    | 1    |   |
| 3                              |     | 1 |   |   |   |   |   |   |   |    |    |      |   |
| 4                              |     | 1 |   |   |   |   |   |   |   |    |    |      |   |
| 5                              |     |   |   |   |   |   | 1 |   |   |    |    |      |   |
| CO (W.A)                       | 2   | 1 |   |   |   |   | 1 |   |   |    |    | 1    |   |



| 22MEX23 - GAS DYNAMICS AND JET PROPULSION                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |   |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|-----|
|                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                              | L                                                                                                                                                                                                                                                                                                                                                                                                                                    | T                                            | P | C   |
|                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                              | 3                                                                                                                                                                                                                                                                                                                                                                                                                                    | 0                                            | 0 | 3   |
| PREREQUISITE : NIL                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |   |     |
| Course Objective:                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                              | <ul style="list-style-type: none"><li>To study the fundamentals of compressible flow concepts and the use of gas tables.</li><li>To learn the compressible flow behaviour in constant area ducts</li><li>To study the development of shock waves and its effects</li><li>To study the types of jet engines and their performance parameters</li><li>To learn the types of rocket engines and their performance parameters.</li></ul> |                                              |   |     |
| Course Outcomes<br>The Student will be able to                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                              | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                      | Weightage of COs in End Semester Examination |   |     |
| CO1                                                                                                                                                                                                                                                                                                                                                                          | Apply the fundamentals of compressible flow concepts and the use of gas tables                                                                                               | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                   | 20%                                          |   |     |
| CO2                                                                                                                                                                                                                                                                                                                                                                          | Analyze the compressible flow behaviour in constant area ducts                                                                                                               | An                                                                                                                                                                                                                                                                                                                                                                                                                                   | 20%                                          |   |     |
| CO3                                                                                                                                                                                                                                                                                                                                                                          | Evaluate the development of shock waves and its effects                                                                                                                      | An                                                                                                                                                                                                                                                                                                                                                                                                                                   | 20%                                          |   |     |
| CO4                                                                                                                                                                                                                                                                                                                                                                          | Analyze the ethical implications and responsibilities associated with the design, development, and operation of compressible fluid flow systems and propulsion technologies. | An                                                                                                                                                                                                                                                                                                                                                                                                                                   | 20%                                          |   |     |
| CO5                                                                                                                                                                                                                                                                                                                                                                          | Classify the rocket engines and their performance parameters.                                                                                                                | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                   | 20%                                          |   |     |
| UNIT I - BASIC CONCEPTS AND ISENTROPIC FLOWS                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |   | (9) |
| Energy and momentum equations of compressible fluid flows, Concepts of compressible flow – Mach waves and Mach cone. Flow regimes, effect of Mach number on compressibility. Stagnation, static, critical properties and their interrelationship. Isentropic flow and its relations. Isentropic flow through variable area ducts – nozzles and diffusers. Use of Gas tables. |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |   |     |
| UNIT II - COMPRESSIBLE FLOW THROUGH DUCTS                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |   | (9) |
| Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction. Use of Gas tables.                                                                                                                                                                                    |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |   |     |
| UNIT III - NORMAL AND OBLIQUE SHOCKS                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |   | (9) |
| Governing equations - Rankine-Hugoniot Relation. Variation of flow parameters across the normal and oblique shocks. Prandtl – Meyer expansion and relation. Use of Gas tables.                                                                                                                                                                                               |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |   |     |
| UNIT IV - JET PROPULSION                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |   | (9) |
| Theory of jet propulsion – thrust equation – Performance parameters - thrust, power and efficiency. Operation, cycle analysis and performance of ram jet, turbojet, turbofan, turbo prop and pulse jet engines.                                                                                                                                                              |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |   |     |
| UNIT V – SPACE PROPULSION                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |   | (9) |
| Types of rocket engines and propellants. Characteristic velocity – thrust equation. Theory of single and multistage rocket propulsion. Liquid fuel feeding systems. Solid propellant geometries. Orbital and escape velocity. Rocket performance calculations.                                                                                                               |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |   |     |
| TOTAL (L:45) = 45 PERIODS                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                              |   |     |

**TEXT BOOKS:**

1. Anderson, J.D., "Modern Compressible flow", Third Edition, McGraw Hill, 2003.
2. S.M.Yahya, "Fundamentals of Compressible Flow with Aircraft and Rocket propulsion", New Age International (P) Limited, 4th Edition, 2012.

**REFERENCES:**

1. R. D. Zucker and O Biblarz, "Fundamentals of Gas Dynamics", 2nd edition, Wiley, 2011. .
2. Balachandran. P., "Fundamentals of Compressible Fluid Dynamics", Prentice-Hall of India, 2007.
3. Radhakrishnan. E., "Gas Dynamics", Printice Hall of India, 2006.
4. Hill and Peterson, "Mechanics and Thermodynamics of Propulsion", Addison – Wesley, 1965.
5. Babu, V., "Fundamentals of Compressible Flow", CRC Press, 1st Edition, 2008

**Mapping of COs with POs / PSOs**

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        | 3   |   |   |   |   |   |   |   |   |    |    | 2    | 1 |
| 2        |     | 3 | 3 |   |   |   |   |   |   |    |    | 2    | 1 |
| 3        |     |   |   |   |   |   |   |   |   |    |    | 2    | 1 |
| 4        |     |   |   |   |   |   | 3 |   |   |    |    | 2    | 1 |
| 5        |     |   |   |   |   |   |   |   |   |    | 3  | 2    | 1 |
| CO (W.A) | 3   | 3 | 3 |   |   | 3 |   |   |   |    | 3  | 3    | 3 |



| 22MEX24 - REFRIGERATION AND AIR CONDITIONING   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                                              |          |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|----------|
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>L</b>        | <b>T</b>                                     | <b>P</b> |
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>3</b>        | <b>0</b>                                     | <b>0</b> |
| <b>PREREQUISITE : NIL</b>                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                                              |          |
| <b>Course Objective:</b>                       | <ul style="list-style-type: none"> <li>To introduce the refrigerants and refrigeration cycles</li> <li>To know the working principles of vapour compression and vapour absorption refrigeration systems.</li> <li>To acquire knowledge on non-conventional refrigeration systems.</li> <li>To acquire knowledge on Air conditioning systems and their components</li> <li>To get exposure on load estimation in</li> <li>Refrigeration and air conditioning systems</li> </ul> |                 |                                              |          |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Cognitive Level | Weightage of COs in End Semester Examination |          |
| CO1                                            | Apply the principles of air and vapor refrigeration cycles to assess system performance and select appropriate refrigerants for different applications.                                                                                                                                                                                                                                                                                                                        | Ap              | 40%                                          |          |
| CO2                                            | Apply the principles of non-conventional refrigeration to evaluate the operation and performance of thermoelectric, vortex tube, and pulse tube systems.                                                                                                                                                                                                                                                                                                                       | Ap              | 20%                                          |          |
| CO3                                            | Analyze various air conditioning systems and equipment based on system classification, performance factors, and application requirements, including noise control considerations.                                                                                                                                                                                                                                                                                              | An              | 20%                                          |          |
| CO4                                            | Analyze cooling and heating load factors and evaluate the design and functional aspects of refrigeration and air conditioning systems for various applications.                                                                                                                                                                                                                                                                                                                | An              | 20%                                          |          |
| CO5                                            | Independently explore refrigeration and air conditioning systems as a team and deliver an effective oral presentation demonstrating technical understanding and communication skills.                                                                                                                                                                                                                                                                                          | U               | Internal Assessment                          |          |

|                                                                                                                                                                                                                                                                                                                 |            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I : AIR REFRIGERATION CYCLES AND REFRIGERANTS</b>                                                                                                                                                                                                                                                       | <b>(9)</b> |
| Refrigeration - systems, Coefficient of Performance - Reversed Carnot cycle - reversed Brayton cycle - Refrigerants - introduction, classification - primary refrigerants - designation - properties and uses of commonly used refrigerants - comparison and application of refrigerants – Leak detection.      |            |
| <b>UNIT II - VAPOUR COMPRESSION AND ABSORPTION REFRIGERATION SYSTEMS</b>                                                                                                                                                                                                                                        | <b>(9)</b> |
| Simple vapour compression system - T-s diagrams - P-h chart - factors affecting the performance - actual vapour compression cycle - volumetric efficiency - methods of improving simple saturation cycle - Simple vapour absorption system - practical vapour absorption system - COP - Lithium Bromide system. |            |
| <b>UNIT III - NON CONVENTIONAL REFRIGERATION SYSTEMS</b>                                                                                                                                                                                                                                                        | <b>(9)</b> |
| Thermoelectric refrigeration system - thermoelectric effects, comparison between thermoelectric and vapour compression refrigeration- vortex tube and pulse tube refrigeration.                                                                                                                                 |            |
| <b>UNIT IV - AIR CONDITIONING SYSTEMS AND EQUIPMENTS</b>                                                                                                                                                                                                                                                        | <b>(9)</b> |
| Air conditioning cycle - classification of air conditioning systems - central system - zoned system - unitary system - unitary central system – VRF/VRV system- selection of system - RSHF - GSHF - applications of air                                                                                         |            |

conditioning - air conditioning equipment - package units, central units - noise and noise control.

**UNIT V – LOAD ESTIMATION, APPLICATIONS OF REFRIGERATION AND AIR CONDITIONING**

(9)

Cooling and heating load - Thermal resistance value (U) for wall, roof, glass, solar radiation and heat gain - thermal barriers - infiltration - internal heat gains - Design of a cold storage - domestic refrigerator - electrical circuit, maintenance - year round air conditioner - year round absorption air conditioner - air conditioning of theatres - manufacture of ice.

**TEXT BOOKS**

1. Rajput.R.K, “A textbook of Refrigeration and Air conditioning”, S.K.Kataria and Sons, 3rd ed., Reprint 2015
2. Arora, C.P., "Refrigeration and Air Conditioning", 4th ed., McGraw Hill, New Delhi, 2021

**REFERENCES:**

1. Ananthanarayanan P.N, “Basic Refrigeration and Air Conditioning”, 4th ed., McGraw Hill, New Delhi, 2013
2. Paul Lang V, “Principles of Air conditioning”, 3rd ed., CBS Publishers and Distributors Pvt Ltd, New Delhi 2003
3. Khurmi.R.S and Gupta.J.K, “A Textbook of Refrigeration and Air Conditioning”, 1st ed., S. Chand Publications, 2011
4. Roy.J.Dossat, “Principles of Refrigeration”, 4th ed., Pearson education inc, New Delhi, 2012

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    | 2    |   |
| 2                              |     | 3 |   |   |   |   |   |   |   |    |    | 2    |   |
| 3                              |     | 3 |   |   |   |   |   |   |   |    |    | 2    |   |
| 4                              |     | 3 |   |   |   |   |   |   |   |    |    | 2    |   |
| 5                              |     |   |   |   |   |   |   |   | 2 |    |    |      |   |
| CO (W. A)                      | 3   | 3 |   |   |   |   |   |   | 2 |    |    | 2    |   |

| 22MEX25 - THERMAL POWER ENGINEERING            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                 |                                              |          |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|----------|
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>L</b>        | <b>T</b>                                     | <b>P</b> |
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>3</b>        | <b>0</b>                                     | <b>0</b> |
| <b>PREREQUISITE : NIL</b>                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                 |                                              |          |
| <b>Course Objective:</b>                       | <ul style="list-style-type: none"> <li>To study the fuel properties and arrive at proximate and ultimate analysis of fuels.</li> <li>To study the different types of boilers and compute their performance parameters.</li> <li>To study the performance parameters of an air compressor.</li> <li>To study the working principles of various refrigeration systems and perform COP calculations.</li> <li>To study the psychrometric properties and how they are utilized in arriving at calculations to determine heating loads.</li> </ul> |                 |                                              |          |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Cognitive Level | Weightage of COs in End Semester Examination |          |
| CO1                                            | Apply knowledge of different fuel types and their properties by performing proximate and ultimate analysis, moisture determination, and calculating gross and net calorific values.                                                                                                                                                                                                                                                                                                                                                           | Ap              | 20%                                          |          |
| CO2                                            | Apply knowledge of boiler types, mountings, accessories, performance calculations, and air compressor classifications and efficiencies to analyze and compare next-generation thermal systems.                                                                                                                                                                                                                                                                                                                                                | Ap              | 40%                                          |          |
| CO3                                            | Analyze the principles and performance of vapor compression, air cycle, absorption, thermoelectric, and advanced refrigeration systems.                                                                                                                                                                                                                                                                                                                                                                                                       | An              | 20%                                          |          |
| CO4                                            | Analyze psychrometric properties, processes, and air conditioning systems to evaluate cooling loads and cooling tower performance.                                                                                                                                                                                                                                                                                                                                                                                                            | An              | 20%                                          |          |
| CO5                                            | Participate in an independent team study and deliver an effective oral presentation on boilers, refrigeration, and air conditioning systems.                                                                                                                                                                                                                                                                                                                                                                                                  | U               | Internal Assessment                          |          |

|                                                                                                                                                                                                                                                                                              |            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I : FUELS AND COMBUSTION</b>                                                                                                                                                                                                                                                         | <b>(9)</b> |
| Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels – Fuels Analysis – Proximate and Ultimate Analysis - Moisture Determination - Calorific Value -Gross & Net Calorific Values                                                                                |            |
| <b>UNIT II - BOILERS</b>                                                                                                                                                                                                                                                                     | <b>(9)</b> |
| Types of boilers and comparison, Mountings and Accessories. Performance calculations, Boiler trial. Next generation boiler design                                                                                                                                                            |            |
| <b>UNIT III - AIR COMPRESSORS</b>                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Classification of air compressors, working principle, work of compression - with and without clearance, Volumetric efficiency, Isothermal efficiency. Multistage air compressor with Intercooling. Working principle and comparison of Rotary compressors with reciprocating air compressors |            |
| <b>UNIT IV - REFRIGERATION SYSTEMS</b>                                                                                                                                                                                                                                                       | <b>(9)</b> |
| Vapour compression refrigeration cycle, Effect of Superheat and Sub-cooling, Performance calculations,                                                                                                                                                                                       |            |

Working principle of air cycle, vapour absorption system, and Thermoelectric refrigeration. Advanced refrigeration and Cryogenics

## UNIT V – PSYCHROMETRY AND AIR-CONDITIONING

(9)

Psychrometric properties – Property calculations using Psychrometric chart and expressions. Psychrometric processes – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing Air conditioning systems, concept of RSHF, GSHF and ESHF, Cooling load calculations. Cooling towers – concept and types.

### TEXT BOOKS:

1. Mahesh. M. Rathore, “Thermal Engineering”, 4th Edition, Tata McGraw Hill, 2023.
2. Ballaney. P, “Thermal Engineering”, 25th Edition, Khanna Publishers, 2017

### REFERENCES:

1. Ananthanarayanan P.N, “Basic Refrigeration and Air-Conditioning”, 4th Edition, Tata McGraw Hill, 2013.
2. Arora, “Refrigeration and Air-Conditioning”, 4th ed., McGraw Hill, New Delhi, 2021.
3. Mathur M.L and Mehta F.S., “Thermal Science and Engineering”, 3rd Edition, Jain Brothers Pvt. Ltd, 2017.
4. Nag P.K, “ Basic and Applied Thermodynamics”, 4th Edition, Tata McGraw Hill, 2017
5. Soman. K, “Thermal Engineering”, 2nd Edition, Prentice Hall of India, 2011

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    | 2    |   |
| 2                              | 3   |   |   |   |   |   |   |   |   |    |    | 2    |   |
| 3                              |     | 3 |   |   |   |   |   |   |   |    |    | 2    |   |
| 4                              | 3   |   |   |   |   |   |   |   |   |    |    | 2    |   |
| 5                              |     |   |   |   |   |   |   | 2 | 2 |    |    |      |   |
| CO (W.A)                       | 3   | 3 |   |   |   |   |   | 2 | 2 |    |    | 2    |   |

| 22MEX26 - RENEWABLE ENERGY TECHNOLOGIES                                                                                                                                                                                                                                                                                     |                                                                                                                                                |                                                                                                                                                                                    |                                              |     |   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----|---|
|                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                | L                                                                                                                                                                                  | T                                            | P   | C |
|                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                | 3                                                                                                                                                                                  | 0                                            | 0   | 3 |
| PREREQUISITE : NIL                                                                                                                                                                                                                                                                                                          |                                                                                                                                                |                                                                                                                                                                                    |                                              |     |   |
| Course Objective:                                                                                                                                                                                                                                                                                                           |                                                                                                                                                | • To analyze the global energy status and potential of various renewable energy sources.<br>• To understand the different types of bio-resources and their conversion technologies |                                              |     |   |
| Course Outcomes<br>The Student will be able to                                                                                                                                                                                                                                                                              |                                                                                                                                                | Cognitive Level                                                                                                                                                                    | Weightage of COs in End Semester Examination |     |   |
| CO1                                                                                                                                                                                                                                                                                                                         | Describe the energy consumption and demands in various sectors like domestic, industrial, commercial, agriculture and transportation in India. | Ap                                                                                                                                                                                 | 20%                                          |     |   |
| CO2                                                                                                                                                                                                                                                                                                                         | Calculate wind energy potential using wind data, considering factors like the Betz limit and site selection for wind farms.                    | Ap                                                                                                                                                                                 | 20%                                          |     |   |
| CO3                                                                                                                                                                                                                                                                                                                         | Analyze and Design the biomass gasifiers, biogas plants, biodiesel production plants and ethanol production systems.                           | An                                                                                                                                                                                 | 20%                                          |     |   |
| CO4                                                                                                                                                                                                                                                                                                                         | Define the methods of hydrogen production and storage and their potential applications in the energy sector                                    | Ap                                                                                                                                                                                 | 20%                                          |     |   |
| CO5                                                                                                                                                                                                                                                                                                                         | Evaluate applications and design the solar thermal collectors, including flat plate and concentrating collectors.                              | E                                                                                                                                                                                  | 20%                                          |     |   |
| UNIT I : ENERGY SCENARIO                                                                                                                                                                                                                                                                                                    |                                                                                                                                                |                                                                                                                                                                                    |                                              |     |   |
|                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                |                                                                                                                                                                                    |                                              | (9) |   |
| Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status- Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans         |                                                                                                                                                |                                                                                                                                                                                    |                                              |     |   |
| UNIT II : SOLAR ENERGY                                                                                                                                                                                                                                                                                                      |                                                                                                                                                |                                                                                                                                                                                    |                                              |     |   |
|                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                |                                                                                                                                                                                    |                                              | (9) |   |
| Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications. |                                                                                                                                                |                                                                                                                                                                                    |                                              |     |   |
| UNIT III : WIND ENERGY                                                                                                                                                                                                                                                                                                      |                                                                                                                                                |                                                                                                                                                                                    |                                              |     |   |
|                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                |                                                                                                                                                                                    |                                              | (9) |   |
| Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.                     |                                                                                                                                                |                                                                                                                                                                                    |                                              |     |   |
| UNIT IV : BIO-ENERGY                                                                                                                                                                                                                                                                                                        |                                                                                                                                                |                                                                                                                                                                                    |                                              |     |   |
|                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                |                                                                                                                                                                                    |                                              | (9) |   |
| Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration – Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.                      |                                                                                                                                                |                                                                                                                                                                                    |                                              |     |   |
| UNIT V : OTHER ENERGY SOURCES                                                                                                                                                                                                                                                                                               |                                                                                                                                                |                                                                                                                                                                                    |                                              |     |   |
|                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                |                                                                                                                                                                                    |                                              | (9) |   |
| Geothermal energy, magneto hydrodynamic system (MHD), thermionic and thermos- electric generator, micro-hydel systems, hybrid systems and applications; Fuel cells: Classification, reactions and performance; Hydrogen production and storage methods.                                                                     |                                                                                                                                                |                                                                                                                                                                                    |                                              |     |   |
| TOTAL=45PERIODS                                                                                                                                                                                                                                                                                                             |                                                                                                                                                |                                                                                                                                                                                    |                                              |     |   |

**TEXT BOOKS:**

1. Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
2. Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

**REFERENCES:**

1. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.
2. Rai.G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.
3. Sukhatme.S.P., "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., "Solar Energy – Fundamentals Design, Modelling and applications", Alpha Science Intl Ltd, 2015.
5. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              |     | 2 | 2 |   |   | 3 |   |   |   |    |    | 3    |   |
| 2                              | 3   | 2 | 2 |   |   | 3 |   |   |   |    |    |      |   |
| 3                              | 3   | 2 | 2 |   |   | 3 |   |   |   |    |    | 3    |   |
| 4                              | 3   | 2 | 2 | 3 |   | 3 |   |   |   |    |    |      |   |
| 5                              | 3   | 2 | 2 |   |   | 3 |   |   |   |    |    | 3    |   |
| CO (W.A)                       | 3   | 2 | 2 | 3 |   | 3 |   |   |   |    |    | 3    |   |





| 22MEX27 - ADVANCED VEHICLE ENGINEERING         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                              |   |   |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | L               | T                                            | P | C |
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                              |   |   |
| Course Objective:                              | <ul style="list-style-type: none"><li>• To introduce the basic concepts of electric vehicle and their characteristics</li><li>• To introduce different types of motors and the selection of motor for vehicle applications.</li><li>• To acquaint the student with different sensors and systems used in autonomous and connected vehicles.</li><li>• To give an overview of networking with sensors and systems.</li><li>• To introduce the modern methods of diagnosing on-board the vehicle troubles.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply the concept of electric vehicles and their importance in automotive.                                                                                                                                                                                                                                                                                                                                                                                                                                         | Ap              | 20%                                          |   |   |
| CO2                                            | Apply the concepts of electric propulsion and compare different types of electric motors used in electric vehicles.                                                                                                                                                                                                                                                                                                                                                                                                | Ap              | 20%                                          |   |   |
| CO3                                            | Analyze the technologies enabling autonomous and connected vehicle systems including sensors and wireless networks.                                                                                                                                                                                                                                                                                                                                                                                                | An              | 20%                                          |   |   |
| CO4                                            | Analyze automotive network systems and communication protocols used in modern intelligent                                                                                                                                                                                                                                                                                                                                                                                                                          | An              | 40%                                          |   |   |
| CO5                                            | Apply knowledge of electric and autonomous vehicle technologies to prepare and present a project or case study on current industry practices.                                                                                                                                                                                                                                                                                                                                                                      | Ap              | Internal Assessment                          |   |   |

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| <b>UNIT I - ELECTRIC VEHICLES</b>                                                                                                                                                                                                                                                                                                                | (9) |
| EV architectures, advantages and disadvantages, Electrical and mechanical energy storage technologies, battery management. Performance of Electric Vehicles, Electric Power Steering. Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving.                                                      |     |
| <b>UNIT II - ELECTRIC VEHICLE MOTORS</b>                                                                                                                                                                                                                                                                                                         | (9) |
| Electric Propulsion basics, motor capacity determination, Induction motor, DC motor, Permanent Magnet Motor, Switch Reluctance Motor, Configuration, Characteristics, Performance and control of Drives.                                                                                                                                         |     |
| <b>UNIT III - AUTONOMOUS AND CONNECTED VEHICLES</b>                                                                                                                                                                                                                                                                                              | (9) |
| Vehicle-to-Vehicle Technology, Vehicle to Road and Vehicle to Vehicle Infrastructure, Basic Control System, Surroundings Sensing Systems, Role of Wireless Data Networks, Advanced Driver Assistance Systems, Basics of Radar System, Ultrasonic Sonar Systems, Lidar System, Camera Technology, Basics of Wireless Technology, Receiver System. |     |

|                                                                                                                                                                                      |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT IV - AUTOMOTIVE NETWORKING</b>                                                                                                                                               | (9) |
| Bus Systems – Classification, Applications in the vehicle, Coupling of networks, networked vehicles, Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces. |     |
| <b>UNIT V - ON-BOARD TESTING</b>                                                                                                                                                     | (9) |
| Integration of Sensor Data to On-Board Control Systems (OBD), OBD requirements, certification, enforcement, systems, testing, Introduction to Cyber-physical system.                 |     |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                     |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
| <ol style="list-style-type: none"> <li>1. John G Hayes and G AbaasGoodarzi, Electric Powertrain -, 1st Edition, John Wiley &amp; Sons Ltd., 2018</li> <li>2. Hussain T Mouftah, Melike Erol-kantarci and Samesh Sorour, Connected and Autonomous Vehicles in Smart Cities,CRC Press, 1st Edition, 2020.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                    |  |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
| <ol style="list-style-type: none"> <li>1. Dominique Paret, Multiplexed Networks for Embedded Systems, John Wiley &amp; Sons Ltd., 2007.</li> <li>2. Hong Cheng, - Autonomous Intelligent Vehicles: Theory, Algorithms &amp; Implementation, Springer, 2011</li> <li>3. Advanced Technology Vehicles Manufacturing (ATVM) Loan Program (Energy Science, Engineering and Technology: Congressional Policies, Practices and Procedures)by Andrew M Wright and Harrison R Scott   5 September 2012</li> <li>4. Advanced Vehicle Technology by Heinz Heisler MSc BSc FIMI MIRTE MCIT   17 July 2002</li> <li>5. Advanced Motorsport Engineering: Units for Study at Level 3by Andrew Livesey   1 September 2011</li> </ol> |  |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 2   |   |   |   |   |   |   |   |   |    |    | 1    |   |
| 2                              | 2   |   |   |   |   |   |   |   |   |    |    | 1    |   |
| 3                              |     | 1 |   |   |   |   |   |   |   |    |    |      |   |
| 4                              |     | 1 |   |   |   |   |   |   |   |    |    |      |   |
| 5                              |     |   |   |   |   |   |   |   | 1 |    |    |      |   |
| CO (W.A)                       | 2   | 1 |   |   |   |   |   |   | 1 |    |    | 1    |   |



| 22MEX28 - POWER PLANT ENGINEERING                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                      |                        |                                                     |          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>L</b>                                                                                                                                                                             | <b>T</b>               | <b>P</b>                                            | <b>C</b> |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>3</b>                                                                                                                                                                             | <b>0</b>               | <b>0</b>                                            | <b>3</b> |
| <b>PRE REQUISITE: NIL</b>                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                      |                        |                                                     |          |
| <b>Course Objectives</b> <ul style="list-style-type: none"> <li>To acquire knowledge on working principle of steam power plant</li> <li>To understand the working principle of gas turbine power plant</li> <li>To introduce the principles and operation of nuclear power plant and its economics</li> <li>To introduce the principles and operation of a power plant and its economics.</li> <li>To introduce the principles and its economics.</li> </ul> |                                                                                                                                                                                      |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                      | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Apply the working principles of steam power plant components to identify suitable equipment configurations for specific power generation requirements                                | Ap                     | 20%                                                 |          |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Apply knowledge of diesel and gas turbine systems to evaluate performance characteristics and operational efficiency in industrial power generation                                  | Ap                     | 20%                                                 |          |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Analyze the design features and operational principles of nuclear power systems to determine their suitability for sustainable energy production                                     | An                     | 20%                                                 |          |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Analyze the impact of different types of renewable energy power plants and economic factors on plant selection, cost efficiency, and load management in various industrial scenarios | An                     | 40%                                                 |          |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Analysis of the power generation in various power plants in India.                                                                                                                   | An                     | Internal Assessment                                 |          |

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| <b>UNIT I : STEAM POWER PLANT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>(9)</b> |
| . Essentials of steam power plant equipment - coal handling - fuel burning furnaces - methods of fuel firing - pulverizing mills - ball mill, ball and race mill, shaft mill - pulverized coal firing - steam condensers - surface condensers, jet condensers, cooling tower- ash disposal - handling equipment - smoke and dust removal - dust collectors - fluidized bed combustion - types - boiler - classification, working principles of Cochran boiler and La Mont boiler |            |
| <b>UNIT II : DIESEL AND GAS TURBINE POWER PLANT</b>                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>(9)</b> |
| Diesel engines - heavy oil engines - dual fuel engines - high compression gas engines - general layout of diesel power plant - performance of characteristics diesel engine - fuel system - common rail injection, individual pump injection, distributor system - diesel plant operation, efficiency - heat balance of a diesel engine power plant - Gas Turbine power plants. Combined Cycle Power Plants                                                                      |            |
| <b>UNIT III : NUCLEAR POWER PLANT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Nuclear energy concepts and terms - energy from nuclear fission - radioactivity - nuclear reactor - parts, nuclear fuel, moderator, moderating ratio, reflector, reactor vessel, biological shielding, coolant, nuclear reactor, classification of nuclear reactors, Pressurized Water Reactor (PWR), Boiling Water Reactor (BWR), CANDU Reactor - Safety measures for Nuclear Power plants.                                                                                     |            |

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| <b>UNIT IV : RENEWABLE ENERGY SOURCES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>(9)</b> |
| Classification of energy - construction and working principles of solar energy, flat plate collectors, focusing collector, solar pond technology, low temperature thermal power generation, medium temperature systems using focusing collectors, high temperature systems – solar farm and solar power plant - wind, ocean thermal and geothermal power plant - Fuel Cell power systems, Recent developments in the area of renewable energy systems                                                                                                                 |            |
| <b>UNIT V : HYDROELECTRIC POWER PLANT AND POWER PLANT ECONOMICS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>(9)</b> |
| Hydroelectric power plant - run-off - selection of site - essential features -pumped storage plants, economics - terms and factors - factors affecting power plant design - effect of power plant type - costs, rates, fixed elements, customer elements - plant selection, power generation - load curves - ideal and realized load curves - Waste Heat Recovery Boilers in Cement, Sugar and Steel Plants.                                                                                                                                                          |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |
| <b>TEXT BOOKS</b> <ol style="list-style-type: none"> <li>1. El.Wakil. M. M, “Power Plant Technology”, McGraw-Hill Higher Education, 2017</li> <li>2. Raja.A.K, Amit Prakash Srivastava, Manish Dwivedi, “Power Plant Engineering”, New Age International (P) Limited, 1st ed., Reprint 2010</li> </ol>                                                                                                                                                                                                                                                                |            |
| <b>REFERENCES:</b> <ol style="list-style-type: none"> <li>1. Rajput .R.K, “A Textbook of Power Plant Engineering”, 5th ed., Laxmi Publications, New Delhi, 2016</li> <li>2. Nag.P.K, "Power Plant Engineering", 4th ed., Tata McGraw Hill Publishing Company Ltd, 2014</li> <li>3. Arora .S.C, Domkundwar, “Power Plant Engineering”, 6th ed., Dhanpat Rai &amp; Co, 2013</li> <li>4. Manoj Kumar Gupta, “Power Plant Engineering”, 1st ed., Prentice Hall India, 2010</li> <li>5. Black, Veatch, “Power Plant Engineering”, 1st ed., CBS Publishers, 2005</li> </ol> |            |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    | 2    |   |
| 2                              |     | 2 |   |   |   |   |   |   |   |    |    | 2    |   |
| 3                              |     |   | 2 |   |   |   |   |   |   |    |    |      |   |
| 4                              |     |   |   |   | 2 |   |   |   |   |    |    |      | 2 |
| 5                              | 2   |   |   |   |   |   |   |   |   |    |    |      | 2 |
| <b>CO (W.A)</b>                | 2.5 | 2 | 2 |   | 2 |   |   |   |   |    |    | 2    | 2 |



| 22MEX29 - Green Engineering and AI-Driven Energy Systems |                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
|----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                          |                                                                                                                                         | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | T                                            | P | C |
|                                                          |                                                                                                                                         | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                                       |                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| Course Objective:                                        |                                                                                                                                         | <ul style="list-style-type: none"><li>• Understand the principles of green engineering and sustainable energy systems.</li><li>• Explain renewable energy technologies and industrial energy management practices.</li><li>• Apply Artificial Intelligence techniques for monitoring and optimization of thermal energy systems.</li><li>• Analyze AI-based energy management strategies for sustainable industrial applications.</li><li>• Explore emerging green technologies and future trends in AI-driven energy systems.</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to           |                                                                                                                                         | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Weightage of COs in End Semester Examination |   |   |
| CO1                                                      | Apply green engineering principles and life-cycle thinking to evaluate the sustainability of thermal and energy systems                 | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 20%                                          |   |   |
| CO2                                                      | Apply energy auditing, energy conservation and renewable energy concepts to improve the performance of thermal energy systems.          | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 20%                                          |   |   |
| CO3                                                      | Apply appropriate Artificial Intelligence techniques for prediction and performance monitoring of thermal and renewable energy systems. | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 20%                                          |   |   |
| CO4                                                      | Analyze data-driven energy management strategies for optimizing thermal systems and integrated energy systems.                          | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 20%                                          |   |   |
| CO5                                                      | Analyze emerging AI-enabled green technologies for developing sustainable and energy-efficient thermal engineering solutions..          | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 20%                                          |   |   |

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| <b>UNIT I – Green Engineering and Sustainability in Thermal Systems</b>                                                                                                                                                                                                                                                                                                                                      | <b>(9)</b> |
| Principles of Green Engineering—Sustainable Development Goals—Environmental impacts of energy conversion systems—Greenhouse gas emissions and carbon footprint—Life Cycle Assessment (LCA) of energy systems—Industrial ecology and circular economy—Resource conservation—Energy efficiency indicators—Net-zero energy and carbon neutrality—Sustainable design of thermal systems.                         |            |
| <b>UNIT II – Energy Conservation and Sustainable Thermal Energy Systems</b>                                                                                                                                                                                                                                                                                                                                  | <b>(9)</b> |
| Energy auditing and energy balance—Energy efficiency improvement in thermal systems—Waste heat recovery—Cogeneration and trigeneration—Solar thermal energy systems—Biomass energy conversion—Hydrogen energy and fuel cells—Thermal energy storage—Hybrid renewable energy systems—Applications in industrial energy systems.                                                                               |            |
| <b>UNIT III – AI Applications in Thermal and Renewable Energy Systems</b>                                                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Engineering data acquisition and preprocessing—Feature selection and engineering—Regression and classification techniques—Decision trees and Artificial Neural Networks—AI-based performance prediction of boilers, furnaces and heat exchangers—Solar radiation and thermal energy forecasting—Wind energy prediction—Predictive maintenance of thermal equipment—Digital twins for thermal energy systems. |            |

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| <b>UNIT IV – AI-Based Energy Management and Optimization</b>                                                                                                                                                                                                                                                                                                                                                                              | <b>(9)</b> |
| Energy Management Systems (EMS)—IoT-enabled energy monitoring—Demand and thermal load forecasting—AI-based optimization of HVAC systems—Energy optimization in industrial thermal systems—Performance optimization of cogeneration systems—Battery and thermal energy storage management—Smart microgrids and integrated energy systems—Data-driven predictive maintenance.                                                               |            |
| <b>UNIT V – Emerging Green Technologies and AI-Driven Energy Systems</b>                                                                                                                                                                                                                                                                                                                                                                  | <b>(9)</b> |
| Green hydrogen production and utilization—AI applications in fuel cell systems—Carbon Capture, Utilization and Storage (CCUS)—AI-enabled renewable energy integration—Advanced thermal energy storage—Digital twins for sustainable energy systems—AI-based carbon emission reduction—Circular economy in energy systems—Technical, ethical and cybersecurity challenges—Recent advances in AI-driven sustainable thermal energy systems. |            |
| <b>TOTAL(L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                           |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <ol style="list-style-type: none"> <li>1. Henrik Lund, “Renewable Energy Systems: A Smart Energy Systems Approach to the Choice and Modeling of Fully Decarbonized Societies”, 3rd ed., Elsevier, 2024.</li> <li>2. Mohammad-Hassan Khooban (Ed.), “Applications of Deep Machine Learning in Future Energy Systems”, 1st ed., Elsevier, 2024</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <ol style="list-style-type: none"> <li>1. Ajay Kumar Vyas, S. Balamurugan, Kamal Kant Hiran and Harsh S. Dhiman (Eds.), “Artificial Intelligence for Renewable Energy Systems”, 1st ed., Wiley, 2022.</li> <li>2. Sarah El Himer, Mariyam Ouaisa, Abdulrahman A. A. Emhemed, Mariya Ouaisa and Zakaria Boulouard (Eds.), “Artificial Intelligence of Things for Smart Green Energy Management”, 1st ed., Springer, 2022.</li> <li>3. Mukhdeep Singh Manshahia, Valeriy Kharchenko, Gerhard-Wilhelm Weber and Pandian Vasant (Eds.), “Advances in Artificial Intelligence for Renewable Energy Systems and Energy Autonomy”, 1st ed., Springer, 2023.</li> <li>4. Yasar Demirel and Marc A. Rosen, “Sustainable Engineering: Process Intensification, Energy Analysis, and Artificial Intelligence”, 1st ed., CRC Press, 2023.</li> <li>5. Namrata Manohar, Mousmi Ajay Chaurasia, Stefan Mozar and Chia-Feng Juang, “Machine Learning Applications in Renewable Energy”, 1st ed., Springer, 2025.</li> </ol> |

| Mapping of COs with POs / PSOs |     |     |   |   |     |     |   |   |   |    |     |      |     |
|--------------------------------|-----|-----|---|---|-----|-----|---|---|---|----|-----|------|-----|
| COs                            | POs |     |   |   |     |     |   |   |   |    |     | PSOs |     |
|                                | 1   | 2   | 3 | 4 | 5   | 6   | 7 | 8 | 9 | 10 | 11  | 1    | 2   |
| 1                              | 2   | 2   |   |   | 1   | 3   | 1 |   |   |    | 2   | 2    | 1   |
| 2                              | 3   | 3   |   |   | 2   | 3   |   |   |   |    | 2   | 3    | 2   |
| 3                              | 2   | 2   |   |   | 3   | 2   |   |   |   |    | 3   | 2    | 3   |
| 4                              | 3   | 3   |   |   | 3   | 2   |   |   |   |    | 3   | 3    | 3   |
| 5                              | 2   | 3   |   |   | 3   | 3   |   |   |   |    | 3   | 3    | 3   |
| CO (W.A)                       | 2.4 | 2.6 |   |   | 2.4 | 2.6 | 1 |   |   |    | 2.6 | 2.6  | 2.4 |

*Signature*

| 22MEX31 - COMPUTATIONAL SOLID MECHANICS        |                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |                 |   |                                              |   |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----------------|---|----------------------------------------------|---|
|                                                |                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | L               | T | P                                            | C |
|                                                |                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | 3               | 0 | 0                                            | 3 |
| PREREQUISITE : NIL                             |                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |                 |   |                                              |   |
| Course Objective:                              |                                                                                                                    | <ul style="list-style-type: none"><li>• To study the definition and basics on theory of elasticity</li><li>• To learn finite element method and procedure for static linear elasticity</li><li>• To study the Non Linear and History depend problems</li><li>• To study time dependent and dynamic problems of Small and large strain visco-plasticity</li><li>• To study Structural Elements &amp; Interfaces and contact using penalty method</li></ul> |  |                 |   |                                              |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | Cognitive Level |   | Weightage of COs in End Semester Examination |   |
| CO1                                            | Utilize the theory of elasticity to solve basic problems in structural analysis.                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | Ap              |   | 40%                                          |   |
| CO2                                            | Differentiate between non-linear problems and history-dependent problems in the context of structural mechanics.   |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | An              |   | 20%                                          |   |
| CO3                                            | Evaluate methods for solving structural elements, interfaces, and contact problems.                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | Ap              |   | 20%                                          |   |
| CO4                                            | Derive the finite element method for static linear elasticity from first principles.                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | Ap              |   | 20%                                          |   |
| CO5                                            | Develop teamwork and collaboration skills through group-based on the solid mechanics assignments and peer reviews. |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  | Ap              |   | Internal Assessment                          |   |

|                                                                                                                                                                                                                                                                                                                                                                                             |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I – BASIC ON THEORY OF ELASTICITY</b>                                                                                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Definitions- notations and sign conventions for stress and strain, Equations of equilibrium. Strain – displacement relations, Stress – strain relations, Lamé's constant – cubical dilation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for stresses and strains, Principal stresses and principal strains, Mohr's circle, Saint Venant's principle. |            |
| <b>UNIT II – FINITE ELEMENT METHOD FOR STATIC LINEAR ELASTICITY</b>                                                                                                                                                                                                                                                                                                                         | <b>(9)</b> |
| Derivation and implementation of a basic 2D FE code with triangular constant strain elements. Generalization of finite element procedures for linear elasticity: interpolation and numerical integration in 1D, 2D and 3D. Deriving finite element equations – constructing variational forms; mixed methods. Accuracy and convergence; the Patch test.                                     |            |
| <b>UNIT III – NON LINEAR AND HISTORY DEPEND PROBLEMS</b>                                                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Small strain hypo-elastic materials – Small strain visco-plasticity – Large strain elasticity -Large strain visco-plasticity                                                                                                                                                                                                                                                                |            |
| <b>UNIT IV – TIME DEPENDENT AND DYNAMIC PROBLEMS</b>                                                                                                                                                                                                                                                                                                                                        | <b>(9)</b> |
| First-order systems – the diffusion equation – Explicit time integration – the Newmark method – Implicit time integration – Modal analysis and modal time integration.                                                                                                                                                                                                                      |            |
| <b>UNIT V – AXISYMMETRIC CONTINUUM AND PLANE TRUSS</b>                                                                                                                                                                                                                                                                                                                                      | <b>(9)</b> |
| Axisymmetric formulation – Element stiffness matrix and force vector – Body forces and temperature effects – Stress calculations – Boundary conditions – 2D axis symmetric elements.                                                                                                                                                                                                        |            |

**TEXT BOOKS:**

1. L.S.Srinath, Advanced Mechanics Of Solids, 3<sup>rd</sup> Edition 2008.( 0070139881 · 9780070139886).
2. J.N.Reddy, Introduction To Finite Element Method, 4<sup>th</sup> Edition 2020. (939038527X · 9789390385270).
3. R.D.Cook, Concepts and Applications of Finite Element Analysis, 4<sup>th</sup> Edition 2001 (978- 0-471-35605-9).
4. S.Timoshenko, Theory of Elasticity, McGraw-Hill Education (India) Pvt Limited, 2010.( 9780070701229-0070701229)
5. G. Ramamurty, Applied Finite Element Analysis, I.K. International Publishing House Pvt. Limited,2013. (9789380578453- 9380578458)

**REFERENCES:**

1. The Mechanics of Solids and Structures – Hierarchical Modeling and the Finite Element Solution (Computational Fluid and Solid Mechanics)by Miguel Luiz Buclelem and KlausJürgen Bathe | 25 February 2013
2. The Finite Element Analysis of Shells – Fundamentals (Computational Fluid and Solid Mechanics)by Dominique Chapelle and Klaus-Jürgen Bathe | 27 January 2013
3. Inelastic Analysis of Solids and Structures (Computational Fluid and Solid Mechanics)by M. Kojic and Klaus-Jürgen Bathe | 22 October 2010
4. High-Resolution Methods for Incompressible and Low-Speed Flows (Computational Fluid and Solid Mechanics)by D. Drikakis and W. Rider | 22 October 2010
5. Discontinuous Finite Elements in Fluid Dynamics and Heat Transfer (Computational Fluid and Solid Mechanics)by Ben Q. Li | 22 October 2010

**Mapping of COs with POs / PSOs**

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 2        |     | 3 |   |   |   |   |   |   |   |    |    | 3    |   |
| 3        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 4        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 5        | 3   |   |   |   |   |   |   | 1 | 1 |    |    | 3    |   |
| CO (W.A) | 3   | 3 |   |   |   |   |   | 1 | 1 |    |    | 3    |   |



| 22MEX32 - COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
|----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                          |                                                                                                                             | L                                                                                                                                                                                                                                                                                                                                                                                                                                                        | T                                            | P | C |
|                                                          |                                                                                                                             | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                                       |                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| Course Objective:                                        |                                                                                                                             | <ul style="list-style-type: none"><li>• To study the fluid flow simulation techniques and its mathematical behaviour</li><li>• To learn the discretise 1D and 2D systems using finite difference and finite volume techniques</li><li>• To Formulate diffusion – convection problems using finite volume method</li><li>• To study the flow field for different types of grids</li><li>• To learn the need for turbulence models and its types</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to           |                                                                                                                             | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                          | Weightage of COs in End Semester Examination |   |   |
| CO1                                                      | Apply the governing equations and numerical discretization techniques used in Computational Fluid Dynamics.                 | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 20%                                          |   |   |
| CO2                                                      | Apply finite difference and finite volume methods to model 1D and 2D diffusion problems.                                    | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 20%                                          |   |   |
| CO3                                                      | Apply various differencing schemes to solve convection-diffusion problems and assess stability.                             | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 20%                                          |   |   |
| CO4                                                      | Analyze the mathematical classification of PDEs and interpret their behavior in CFD applications.                           | An                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 40%                                          |   |   |
| CO5                                                      | Analyze and present CFD simulations or case studies using commercial/open-source CFD software for engineering applications. | An                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                  |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT I - COMPUTATIONAL FLUID DYNAMICS</b>                                                                                                                                                                                                                                                                                                                                                                                                     | (9) |
| Basics of Computational Fluid Dynamics – Governing equations– Continuity, Momentum and Energy equations – Boundary conditions & Types– Time-averaged equations for Turbulent Flow – Classification and Mathematical behavior of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations, comparison between Analytical, Experimental and Numerical techniques, Techniques of Discretisation and Numerical errors. Post processing techniques. |     |
| <b>UNIT II - FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION</b>                                                                                                                                                                                                                                                                                                                                                                       | (9) |
| Derivation of finite difference equations– General Methods for first and second order accuracy – Finite volume formulation for steady and transient diffusion 1D and 2D problems – Use of Finite Difference and Finite Volume methods, Accuracy of solution, optimum step-size, Euler, Crank-Nicolson methods, stability of schemes.                                                                                                             |     |
| <b>UNIT III - FINITE VOLUME METHOD FOR CONVECTION DIFFUSION</b>                                                                                                                                                                                                                                                                                                                                                                                  | (9) |
| Steady one-dimensional convection and diffusion – Central, upwind differencing schemes, properties of discretization schemes, Hybrid, Power-law, Quick Schemes, Computation of Boundary layer flow, von Neumann stability analysis.                                                                                                                                                                                                              |     |

|                                                                                                                                                                                                                                                                                                       |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT IV - FLOW FIELD ANALYSIS</b>                                                                                                                                                                                                                                                                  | (9) |
| Stream function and vorticity, Representation of the pressure gradient term, Staggered grid – Momentum equations, Pressure and Velocity corrections – Pressure Correction equation, Simple algorithm and its variants – PISO Algorithms, Computation of internal and external thermal boundary layer. |     |
| <b>UNIT V - TURBULENCE MODELLING</b>                                                                                                                                                                                                                                                                  | (9) |
| Turbulence model requirement and types, mixing length model, Two equation (k-ε) models – High and low Reynolds number models, LES, DNS, Mesh Generation and refinement Techniques-software tools, Stability of solver, Courant Fredrick Levy number, relaxation factor, and grid independence test.   |     |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                      |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
| 6. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics": The finite volume Method, Pearson Education, 2014 .<br>7. Ghoshdastidar, P.S., "Computational Fluid Dynamics and Heat Transfer", Cengage Learning, 2017.                                                                                                                                                                                                           |  |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
| 1. John. F. Wendt, "Computational Fluid Dynamics – An Introduction", Springer, 2013.<br>2. K. Muralidhar & T.Sundararajan, Computational Fluid Flow and Heat Transfer, Narora Publishing House, 1994.<br>3. Suhas V, Patankar, "Numerical Heat transfer and Fluid flow", Taylor & Francis, 2009.<br>4. Uriel Frisch, Turbulence, Cambridge University Press, 1999.<br>5. Yogesh Jaluria & Kenneth E. Torrance, "Computational Heat Transfer", CRC press, 2002. |  |

| Mapping of COs with POs / PSOs |          |          |   |   |          |          |   |   |   |    |    |          |          |
|--------------------------------|----------|----------|---|---|----------|----------|---|---|---|----|----|----------|----------|
| COs                            | POs      |          |   |   |          |          |   |   |   |    |    | PSOs     |          |
|                                | I        | 2        | 3 | 4 | 5        | 6        | 7 | 8 | 9 | 10 | 11 | I        | 2        |
| 1                              | 2        |          |   |   |          |          |   |   |   |    |    |          |          |
| 2                              | 2        |          |   |   |          |          |   |   |   |    |    |          |          |
| 3                              |          | 2        |   |   | I        |          |   |   |   |    |    | I        | I        |
| 4                              |          | 2        |   |   |          |          |   |   |   |    |    | I        | I        |
| 5                              |          |          |   |   |          | I        |   |   |   |    |    |          |          |
| <b>CO (W.A)</b>                | <b>2</b> | <b>2</b> |   |   | <b>I</b> | <b>I</b> |   |   |   |    |    | <b>I</b> | <b>I</b> |

| 22MEX33 - THEORY ON COMPUTATION AND VISUALIZATION                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                            | L                                                                                                                                                                                                                                                                                                                                                                                                                                        | T                                            | P | C |
|                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                            | 3                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| Course Objective:                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                            | <ul style="list-style-type: none"><li>• To study the concepts and techniques of discrete mathematics for theoretical computer science.</li><li>• To learn different formal languages and their relationship.</li><li>• To classify and construct grammars for different languages and vice-versa</li><li>• To study visualization, graphical and quantitative information</li><li>• To learn Visualization design and data Ink</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                            | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                          | Weightage of COs in End Semester Examination |   |   |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                     | Apply the concepts and techniques of discrete mathematics for theoretical computer science | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                       | 20%                                          |   |   |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                     | Analyze the different formal languages and their relationship                              | An                                                                                                                                                                                                                                                                                                                                                                                                                                       | 20%                                          |   |   |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                     | Classify and construct grammars for different languages and vice-versa                     | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                       | 20%                                          |   |   |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                     | Evaluate the visualization, graphical and quantitative information                         | E                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |   |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                     | Create visualization design and data ink                                                   | C                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |   |
| UNIT I- REVIEW OF MATHEMATICAL THEORY                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| (9)                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| Sets, functions, logical statements, proofs, relations, languages, principal of mathematical induction, strong principle, recursive definitions, structural induction.                                                                                                                                                                                                                                                                  |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| UNIT II - REGULAR LANGUAGES AND FINITE AUTOMATA                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| (9)                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| Regular expressions, regular languages, application of finite automata, automata with output –mealy machine, finite automata, definitions, union- intersection and complement of regular languages, non deterministic finite automata, conversion from NFA to FA, - non deterministic finite automata, conversion of NFA- to NFA, kleene’s theorem, minimization of finite automata, regular and non regular languages – pumping lemma. |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| UNIT III - CONTEXT FREE GRAMMAR (CFG) AND PUSHDOWN AUTOMATA                                                                                                                                                                                                                                                                                                                                                                             |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| (9)                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| Definitions and examples, unions concatenations and kleene’s of context free language, regular grammar for regular language, derivations and ambiguity , unambiguous CFG and algebraic expressions, bacosnaur form (BNF), normal form – CNF. Definitions, deterministic PDA, equivalence of CFG and PDA conversion, pumping lemma for CFL, intersections and complements of CFL, non-CFL.                                               |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| UNIT IV - VALUE OF VISUALIZATION                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| (9)                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| Information visualization, in readings in information visualization, graphical excellence, graphical integrity, sources of graphical integrity in the visual display of quantitative information.                                                                                                                                                                                                                                       |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| UNIT V – VISUALIZATION DESIGN                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| (9)                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |
| The power of representation, data-ink and graphical redesign, data-ink maximization and graphical design, data density and small multiples.                                                                                                                                                                                                                                                                                             |                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                              |   |   |

**TEXT BOOKS:**

1. Introduction to the theory of computation by Michael Sipser.
2. Automata theory, languages, and computation by John Hopcroft, Rajeev Motwani, and Jeffrey Ullman.

**REFERENCES:**

1. Introduction to languages and the theory of computation, 4th by John Martin, Tata Mc Graw Hill
2. An introduction to automata theory and formal languages by Adesh K. Pandey, publisher: S.K. Kataria & AMP ; AMP; Sons
3. Introduction to computer theory by Daniel I. Cohen, John Wiley & Sons, Inc
4. Computation: finite and infinite by Marvin I. Minsky, Prentice-Hall.
5. Hopcroft J.E., Motwani R., Ullman J.D., Introduction to Automata Theory, Languages, and Computation, Pearson Education, 3rd Edition, 2008.

**Mapping of COs with POs / PSOs**

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        | 3   |   |   |   |   |   |   |   |   |    |    | 1    |   |
| 2        |     | 3 |   |   |   |   |   |   |   |    |    | 1    |   |
| 3        |     |   | 2 |   |   |   |   |   |   |    |    | 1    |   |
| 4        |     |   |   | 2 |   |   |   |   |   |    |    | 1    |   |
| 5        |     |   |   |   |   |   |   |   |   |    | 2  |      |   |
| CO (W.A) | 3   | 3 | 2 | 2 |   |   |   |   |   |    | 2  | 1    |   |

| 22MEX34 - COMPUTATIONAL BIO-MECHANICS          |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                |                                              |   |   |
|------------------------------------------------|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                |                                                                                                          | L                                                                                                                                                                                                                                                                                                                                                                                              | T                                            | P | C |
|                                                |                                                                                                          | 3                                                                                                                                                                                                                                                                                                                                                                                              | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                |                                              |   |   |
| Course Objective:                              |                                                                                                          | <ul style="list-style-type: none"><li>• To Introduction of principles and concepts of bio-mechanics.</li><li>• Focuses on the studies of tissues and structure of musculoskeletal system.</li><li>• To study the mechanics of joints and human motion.</li><li>• To explain the computational approaches in biomechanics</li><li>• To learn the quantification of forces and motion.</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                          | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Utilize the principles of mechanics to analyze various biomechanical systems                             | Ap                                                                                                                                                                                                                                                                                                                                                                                             | 40%                                          |   |   |
| CO2                                            | Investigate the tissues and structures of the musculoskeletal system in detail.                          | An                                                                                                                                                                                                                                                                                                                                                                                             | 20%                                          |   |   |
| CO3                                            | Assess the effectiveness of different computational mathematical models applied in biomechanics.         | Ap                                                                                                                                                                                                                                                                                                                                                                                             | 20%                                          |   |   |
| CO4                                            | Formulate new techniques for analyzing and understanding human motion.                                   | Ap                                                                                                                                                                                                                                                                                                                                                                                             | 20%                                          |   |   |
| CO5                                            | Develop teamwork and collaboration skills through group-based biomechanics assignments and peer reviews. | Ap                                                                                                                                                                                                                                                                                                                                                                                             | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                   |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| UNIT I - INTRODUCTION TO BIOMECHANICS                                                                                                                                                                                                                                                             | (9) |
| Perspective of biomechanics, Terminologies, Kinematic and kinetic concepts for analyzing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human Movement, Mechanical properties of soft tissues, bones, and muscles |     |
| UNIT II - BIOMECHANICS OF TISSUES AND STRUCTURES OF THE MUSCULOSKELETAL SYSTEM                                                                                                                                                                                                                    | (9) |
| Biomechanics of Bone, Biomechanics of Articular Cartilage, Tendons and Ligaments, Peripheral Nerves and Spinal Nerve Roots, Skeletal Muscle                                                                                                                                                       |     |
| UNIT III - BIOMECHANICS OF JOINTS AND HUMAN MOTION                                                                                                                                                                                                                                                | (9) |
| Knee, Hip, Foot and Ankle, Lumbar Spine, Cervical Spine, Shoulder, Elbow Wrist, and Hand, Linear kinematic and kinetic aspects of human movement, angular kinematic and kinetic aspects of human movement, equilibrium and human moment.                                                          |     |
| UNIT IV - COMPUTATIONAL APPROACHES IN BIOMECHANICS                                                                                                                                                                                                                                                | (9) |
| Finite Element Analysis in Biomechanics, Computational modelling of Vancouver Periprosthetic Fracture in Femur, Scaffolds, artificial hip and knee joints, Aortic Valve.                                                                                                                          |     |
| UNIT V – GAIT ANALYSIS                                                                                                                                                                                                                                                                            | (9) |
| Exoskeleton design, Ergonomics, Sports mechanics, Performance Analysis, Biomechanical analysis, 3D printing.                                                                                                                                                                                      |     |
| TOTAL(L:45) = 45 PERIODS                                                                                                                                                                                                                                                                          |     |

**TEXT BOOKS:**

1. Susan J Hall, —Basic Biomechanics, 6th Edition, The McGraw-Hill Companies Inc., 2011
2. Jay D Humphrey and Sherry L Delange, —An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, 1st edition, Springer-Verlag, 2010

**REFERENCES:**

1. Margareta Nordin and Victor H Frankel, —Basic Biomechanics of the Musculoskeletal System, 3rd Edition, Lippincott Williams and Wilkins, 2001.
2. Ozkaya, Nihat, Nordin, and Margareta, —Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, 2nd Edition, Springer, 2009.
3. Pritam Pain, Sreerup Banerjee, Goutam Kumar Bose , Advances in Computational Approaches in Biomechanics, 2022
4. Kinetics and Dynamics: From Nano- to Bio-Scale: 12 (Challenges and Advances in Computational Chemistry and Physics) by Piotr Paneth and Agnieszka Dybala-Defratyka | 12 August 2010
5. Computational Approaches to Biochemical Reactivity: 19 (Understanding Chemical Reactivity) by GáborNáray-Szabó and AriehWarshel | 31 March 2002

**Mapping of COs with POs / PSOs**

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 2        |     | 3 |   |   |   |   |   |   |   |    |    | 3    |   |
| 3        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 4        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 5        | 3   |   |   |   |   |   |   | 1 | 1 |    |    | 3    |   |
| CO (W.A) | 3   | 3 |   |   |   |   |   | 1 | 1 |    |    | 3    |   |

| 22MEX35 - DESIGN OF PRESSURE VESSELS                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|-----|
|                                                                                                                                                                                                                                                                                          | L                                                                                                                                                                                                                                                                                                                                                                                                      | T               | P                                            | C   |
|                                                                                                                                                                                                                                                                                          | 3                                                                                                                                                                                                                                                                                                                                                                                                      | 0               | 0                                            | 3   |
| PREREQUISITE : NIL                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              |     |
| Course Objective:                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"><li>To introduce the Mathematical knowledge to design pressure vessels and piping</li><li>To learn the ability to carry of stress analysis in pressure vessels and piping</li><li>To study the design of vessels and theory of reinforcement.</li><li>To study buckling and fracture analysis in vessels.</li><li>To learn piping layout and flow diagram.</li></ul> |                 |                                              |     |
| Course Outcomes<br>The Student will be able to                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                        | Cognitive Level | Weightage of COs in End Semester Examination |     |
| CO1                                                                                                                                                                                                                                                                                      | Apply stress determination methods and understand terminology and efficiency concepts for pressure vessel components.                                                                                                                                                                                                                                                                                  | Ap              | 20%                                          |     |
| CO2                                                                                                                                                                                                                                                                                      | Analyze the stress distribution and thermal effects in various pressure vessel configurations including heads and junctions.                                                                                                                                                                                                                                                                           | An              | 20%                                          |     |
| CO3                                                                                                                                                                                                                                                                                      | Apply design principles for tall and short pressure vessels, considering reinforcements and stress concentrations.                                                                                                                                                                                                                                                                                     | Ap              | 20%                                          |     |
| CO4                                                                                                                                                                                                                                                                                      | Analyze the buckling and fracture behavior of vessels under various loadings including external pressure and axial loads.                                                                                                                                                                                                                                                                              | An              | 40%                                          |     |
| CO5                                                                                                                                                                                                                                                                                      | Apply knowledge of piping systems to create and present a piping layout or perform a basic piping stress analysis using industrial practices.                                                                                                                                                                                                                                                          | Ap              | Internal Assessment                          |     |
| UNIT I - INTRODUCTION                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              | (9) |
| Methods for determining stresses – Terminology and Ligament Efficiency – Applications                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              |     |
| UNIT II - STRESSES IN PRESSURE VESSELS                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              | (9) |
| Introduction – Stresses in a circular ring, cylinder –Dilation of pressure vessels, Membrane stress Analysis of Vessel – Cylindrical, spherical and, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels.                                                      |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              |     |
| UNIT III - DESIGN OF VESSELS                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              | (9) |
| Design of Tall cylindrical self-supporting process columns – Supports for short vertical vessels – Stress concentration at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – Pressure Vessel Design |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              |     |
| UNIT IV - BUCKLING AND FRACTURE ANALYSIS IN VESSELS                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              | (9) |
| Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading. |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              |     |
| UNIT V – PIPING                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              | (9) |
| Introduction – Flow diagram – piping layout and piping stress Analysis.                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              |     |
| TOTAL : 45 PERIODS                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              |     |
| TEXT BOOKS:                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              |     |
| <ol style="list-style-type: none"><li>John F. Harvey, "Theory and Design of Pressure Vessels", CBS Publishers and Distributors, 1987.</li><li>Theory And Design Of Pressure Vessels (Pb 2001) by HARVEY J.F.   I January 2001</li></ol>                                                  |                                                                                                                                                                                                                                                                                                                                                                                                        |                 |                                              |     |

**REFERENCES:**

1. Henry H. Bedner, "Pressure Vessels, Design Hand Book", CBS publishers and Distributors, 1987.
2. Stanley, M. Wales, "Chemical process equipment, selection and Design". Buterworths series in Chemical Engineering, 1988.
3. William. J., Bees, "Approximate Methods in the Design and Analysis of Pressure Vessels and Piping", Pre ASME Pressure Vessels and Piping Conference, 1997.
4. Sam Kannapan, "Introduction to Pipe Stress Analysis". John Wiley and Sons, 1985.
5. Theory and design of Pressure Vessels (Pb 2001) by HARVEY J.F. | 1 January 2001

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              |     |   |   |   |   |   |   |   |   |    |    | 1    |   |
| 2                              | 3   |   |   |   |   |   |   |   |   |    |    | 1    |   |
| 3                              |     | 3 |   |   |   |   |   |   |   |    |    | 1    |   |
| 4                              |     |   | 1 |   |   |   |   |   |   |    |    | 1    |   |
| 5                              |     |   |   |   |   |   |   |   | 1 |    |    | 1    |   |
| <b>CO<br/>(W.A)</b>            | 3   | 3 | 1 |   |   |   |   |   | 1 |    |    | 1    |   |



| 22MEX36 - CAD and CAE                          |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                                              |   |   |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | L               | T                                            | P | C |
|                                                |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                 |                                              |   |   |
| Course Objective:                              |                                                                                                            | <ul style="list-style-type: none"><li>• Applying the fundamental concepts of computer graphics and its tools in a generic framework.</li><li>• Creating and manipulating geometric models using curves, surfaces, and solids.</li><li>• Applying concept of 3D modeling, visual realism, and CAD standard practices in engineering design</li><li>• Developing mathematical models for Boundary Value Problems and their numerical solution.</li><li>• Formulating solution techniques to solve non-linear problems.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Utilize fundamental concepts of computer graphics and its tools within a generic framework.                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Ap              | 20%                                          |   |   |
| CO2                                            | Investigate the concepts of 3D modeling, visual realism, and standard CAD practices in engineering design. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | An              | 20%                                          |   |   |
| CO3                                            | Assess various solution techniques for solving non-linear problems in engineering and design contexts.     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Ap              | 40%                                          |   |   |
| CO4                                            | Develop innovative geometric models using advanced curves, surfaces, and solid manipulation techniques.    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Ap              | 20%                                          |   |   |
| CO5                                            | Develop teamwork and collaboration skills through group-based CAD and CAE assignments and peer reviews.    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Ap              | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - FUNDAMENTALS OF COMPUTER GRAPHICS</b>                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>(6)</b> |
| Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations - Graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation. Standards for computer graphics                                                                                                                                                                                                                     |            |
| <b>UNIT II - GEOMETRIC MODELING</b>                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>(6)</b> |
| Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Surface Modeling – Surface Entities, Representation of Surface, Bezier Surface, B-Spline Surface and Coons Surface. Solid Modeling - Solid Entities, Solid Representation, Boundary Representation (B-Rep), Sweeps Representation, Constructive Solid Geometry (CSG).                                                                                                       |            |
| <b>UNIT III - VISUAL REALISM and CAD STANDARDS</b>                                                                                                                                                                                                                                                                                                                                                                                                                | <b>(6)</b> |
| Need for hidden surface removal, The Depth - Buffer Algorithm, Properties that help in reducing efforts, Scan Line coherence algorithm, Span - Coherence algorithm, Area-Coherence Algorithms, Warnock's Algorithm, Priority Algorithms– shading – coloring – computer animation. Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc. |            |
| <b>UNIT IV - FINITE ELEMENT ANALYSIS</b>                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>(6)</b> |
| Introduction to Finite Element Analysis- Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of Boundary Value Problems – Ritz Method – Finite Element Modelling -Procedure to solving any Analytical or Numerical Problem.                                                                                                                                                                                        |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT V – NON-LINEAR ANALYSIS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>(6)</b> |
| Introduction to Non-linear problems - some solution techniques- computational procedure- material nonlinearity-Plasticity and visco-plasticity, stress stiffening, contact interfaces- problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing -Mesh quality- Error estimate- Introduction to Analysis Software.                                                                                                                                                                   |            |
| <b>CAD &amp; CAE LABORATORY</b><br><b>Experiments</b> <ol style="list-style-type: none"> <li>1. Design and animate Piston Cylinder assembly and motion study using CAD software.</li> <li>2. Design and simulate Connecting rod and crank shaft using CAD software.</li> <li>3. Design and simulate Two Cylinder Engine assembly using CAD software.</li> <li>4. Coupled Simulation of structural /thermal analysis</li> <li>5. Harmonic, Transient and spectrum analysis of simple systems.</li> <li>6. Buckling analysis</li> </ol> |            |
| <b>TOTAL(L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <ol style="list-style-type: none"> <li>1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2007</li> <li>2. Seshu.P, “Textbook of Finite Element Analysis”, PHI Learning Pvt. Ltd., NewDelhi, 2012.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <ol style="list-style-type: none"> <li>1. William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.</li> <li>2. Donald Hearn and M. Pauline Baker “Computer Graphics”. Prentice Hall, Inc, 1992.</li> <li>3. Foley, Wan Dam, Feiner and Hughes – “Computer graphics principles &amp; practice”, Pearson Education - 2003</li> <li>4. Rao, S.S., “The Finite Element Method in Engineering”, 6th Edition, ButterworthHeinemann,2018.</li> <li>5. Reddy,J.N. “Introduction to the Finite Element Method”, 4thEdition, Tata McGrawHill,2018.Nitin S.Gokhale, Sanjay S Deshpande, Sanjeev V Bedekar and Anand N Thite “Practical Finite Element Analysis”, Finite to Infinite; 2008.</li> </ol> |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 2                              |     | 3 |   |   |   |   |   |   |   |    |    | 3    |   |
| 3                              | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 4                              | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 5                              |     |   |   |   | 3 |   |   | 1 | 1 |    |    | 3    |   |
| CO (W.A)                       | 3   | 3 |   |   | 3 |   |   | 1 | 1 |    |    | 3    |   |

**22MEX37 - FAILURE ANALYSIS AND NDT TECHNIQUES**

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

**PREREQUISITE : NIL****Course Objective:**

- To gain knowledge on the need, scope, and methodologies of failure analysis
- To learn the principles and applications of visual and penetrant testing
- To Understand the principles, techniques, and advanced methods of magnetic particle testing
- To learn the principles and techniques of radiographic inspection using X-ray and gamma radiography
- To teach various safety standards and precautions in nondestructive testing methods.

**Course Outcomes**  
 The Student will be able to
**Cognitive Level**
**Weightage of COs in End Semester Examination**

|     |                                                                                                                     |    |     |
|-----|---------------------------------------------------------------------------------------------------------------------|----|-----|
| CO1 | Analyze engineering failures using systematic approaches to determine root causes.                                  | An | 20% |
| CO2 | Apply the principles, methods, and applications of visual inspection, penetrant testing for engineering components. | Ap | 20% |
| CO3 | Apply magnetic particle testing to evaluate and interpret defects in engineering components.                        | Ap | 20% |
| CO4 | Apply various radiographic inspection methods to evaluate and interpret defects in engineering components.          | Ap | 20% |
| CO5 | Apply ultrasonic and eddy current testing methods to evaluate and interpret defects in engineering components.      | Ap | 20% |

**UNIT I - FAILURE ANALYSIS****(9)**

Introduction and need and scope of failure analysis. Engineering Disasters and understanding failure analysis. Fundamental sources of failures. Failure modes and effects analysis (FMEA) in industry. Role of root cause analysis (RCA) in failure investigation. failure prevention strategies: Design optimization, material selection, quality control

**UNIT II - VISUAL INSPECTION AND PENETRANT TESTING****(9)**

Non destructive testing - advantages- comparison between destructive and non destructive testing -visual inspection - basic terms, equipments used - machine vision Health and safety considerations in NDT: Personal protective equipment (PPE), exposure limits-Principle of penetrant testing - test stations - accessories - applications - types of penetrants - characteristics of good penetrants - developer and its types - quality and process control - health and safety precautions in Liquid penetrant Inspection.

**UNIT III : MAGNETIC PARTICLE TESTING****(9)**

Principle of Magnetic particle testing - scope - basic terms associated with magnetic materials, classification of magnetic materials - magnetic field orientation - direct magnetization, indirect magnetization - DC and AC magnetization – skin effect - equipments - lights - magnetic field indicator - Advanced magnetic particle testing methods: Multi-directional magnetization, rotational magnetization, automated magnetic particle inspection systems: Robotics, Computer vision Integration, Emerging trends in magnetic particle inspection: Nano-particle enhanced testing.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT IV: RADIOGRAPHIC INSPECTION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>(9)</b> |
| Types of radiations - X-Ray radiography principle - X ray tube generator - gamma radiation sources - advantages of gamma rays over X ray radiography - X-Ray film and accessories - film interpretation - digital radiography - precautions against radiation hazards and health - Real-time radiography and tomography techniques. Radiographic image interpretation: Defect detection and sizing                                                                                                                      |            |
| <b>UNIT V : ULTRASONIC AND EDDY CURRENT TESTING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>(9)</b> |
| Principle of ultrasonic testing - equipments used in ultrasonic testing -Ultrasonic inspection techniques – transmission method, pulse echo method, immersion technique, angle beam technique- applications – cathode ray oscilloscope – Ultrasonic testing for composite materials and additive manufacturing parts- Introduction to Phased Array Ultrasonic Testing (PAUT).Eddy current testing - working principle - basic terms -factors affecting eddy currents - eddy current flow characteristics - applications |            |
| <b>TOTAL=45PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |            |

#### TEXTBOOKS:

1. Osama Lari, Rajeev Kumar, “Basics of Non-Destructive testing”, 1st ed., S.K.Kataria and Sons, 2013
2. Baldev Raj, T.Jayakumar, M.Thavasimuthu Practical Non-Destructive Testing, Narosa Publishing House, 2014.

#### REFERENCES:

1. ASM International, “ASM Handbook: Nondestructive Evaluation and Quality Control - Volume 17”, 9th Revised edition, 1989
2. Charles, J. Hellier, Handbook of Non destructive evaluation, McGraw Hill, New York 2001.
3. Ravi Prakash, “Non-Destructive Testing Techniques”, First Revised edition, New Age International (P) Limited, 2010
4. Prasad.J and Nair.C.G.K, “Non-Destructive Test and Evaluation of Materials”, 2nd ed., Tata McGraw-Hill Publishing company Limited, 2011
5. Yoshida Kenichi and Laodeno Rem N, “Non-Destructive Testing Technique”, LAP Lambert Academic Publishing, 2013

| Mapping of COs with POs / PSOs |          |          |   |   |   |   |   |   |   |    |    |          |          |
|--------------------------------|----------|----------|---|---|---|---|---|---|---|----|----|----------|----------|
| COs                            | POs      |          |   |   |   |   |   |   |   |    |    | PSOs     |          |
|                                | 1        | 2        | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1        | 2        |
| <b>1</b>                       |          | 3        |   |   |   |   |   |   |   |    |    | 3        | 2        |
| <b>2</b>                       | 3        |          |   |   |   |   |   |   |   |    |    | 3        | 2        |
| <b>3</b>                       | 3        |          |   |   |   |   |   |   |   |    |    | 3        |          |
| <b>4</b>                       | 3        |          |   |   |   |   |   |   |   |    |    | 3        |          |
| <b>5</b>                       | 3        |          |   |   |   |   |   |   |   |    |    | 3        |          |
| <b>CO (W.A)</b>                | <b>3</b> | <b>3</b> |   |   |   |   |   |   |   |    |    | <b>3</b> | <b>2</b> |

| 22MEX38 - MACHINE LEARNING FOR INTELLIGENT SYSTEMS |                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |   |
|----------------------------------------------------|----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                    |                                                                            | L                                                                                                                                                                                                                                                                                                                                                                                                                                                         | T                                            | P | C |
|                                                    |                                                                            | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                                 |                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |   |
| Course Objective:                                  |                                                                            | <ul style="list-style-type: none"><li>• To introduce basic machine learning techniques such as regression, classification</li><li>• To learn about introduction of clustering, types and segmentation methods</li><li>• To learn about fuzzy logic, fuzzification and defuzzification</li><li>• To learn about basics of neural networks and neuro fuzzy networks</li><li>• To learn about recurrent neural networks and reinforcement learning</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to     |                                                                            | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                           | Weightage of COs in End Semester Examination |   |   |
| CO1                                                | Apply basic machine learning techniques such as regression, classification | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |   |
| CO2                                                | Develop and analyze clustering and segmentation methods                    | An                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |   |
| CO3                                                | Applying a fuzzy logic system with fuzzification and defuzzification.      | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 40%                                          |   |   |
| CO4                                                | Apply the concepts of neural networks and neuro fuzzy networks             | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |   |
| CO5                                                | Improve knowledge on reinforcement learning                                | U                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                   |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| UNIT I- INTRODUCTION TO MACHINE LEARNING                                                                                                                                                                                                                                                                                                                          | (9) |
| Philosophy of learning in computers, overview of different forms of learning, classifications vs. regression, evaluation metrics and loss functions in classification, evaluation metrics and loss functions in regression, applications of ai in robotics.                                                                                                       |     |
| UNIT II - CLUSTERING AND SEGMENTATION METHODS                                                                                                                                                                                                                                                                                                                     | (9) |
| Introduction to clustering, types of clustering, agglomerative clustering, K-means clustering, mean shift clustering, K-means clustering application study, Introduction to recognition, K-nearest neighbor algorithm, KNN application case study, principal component analysis (PCA), PCA application case study in feature selection for robot guidance.        |     |
| UNIT III - FUZZY LOGIC                                                                                                                                                                                                                                                                                                                                            | (9) |
| Introduction to fuzzy sets, classical and fuzzy sets, overview of classical sets, membership function, fuzzy rule generation, fuzzy rule generation, operations on fuzzy sets, numerical examples, fuzzy arithmetic, numerical examples, fuzzy logic, fuzzification, fuzzy sets, defuzzification, application case study of fuzzy logic for robotics application. |     |
| UNIT IV - NEURAL NETWORKS                                                                                                                                                                                                                                                                                                                                         | (9) |
| Mathematical models of neurons, ANN architecture, learning rules, multi-layer perceptrons, back propagation, introduction of neuro-fuzzy systems, architecture of neuro fuzzy networks, application case study of neural networks in robotics.                                                                                                                    |     |

|                                                                                                                                                                                                                                                                                                              |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT V – RNN AND REINFORCEMENT LEARNING</b>                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Unfolding computational graphs, recurrent neural networks, application case study of recurrent networks in robotics, reinforcement learning, examples for reinforcement learning, markov decision process, major components of RL, Q-learning. application case study of reinforcement learning in robotics. |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                             |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <ol style="list-style-type: none"> <li>1. Micheal negnevitsky, artificial intelligence: a guide to intelligent systems, 3rd edition, addison wesley, england, 2011.</li> <li>2. The Elements of Statistical Learning, by Trevor Hastie, Robert Tibshirani, Jerome H. Friedman (freely available online)</li> <li>3. Pattern Recognition and Machine Learning, by Christopher Bishop.</li> </ol>                                                                                                                                                                                                                              |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <ol style="list-style-type: none"> <li>1. Bruno Siciliano, Oussama Khatib, "Handbook of Robotics", 2016 2nd Edition, Springer</li> <li>2. Simon haykin, "neural networks and learning machines: a comprehensive foundation", third edition, Pearson, Delhi 2016.</li> <li>3. Timothy j ross, "fuzzy logic with engineering applications", 4th edition, chichester, 2011, Sussex Wiley.</li> <li>4. Ian Goodfellow, Yoshua Bengio, Aaron Courville**, *Deep Learning*, 1st Edition, MIT Press, 2016.</li> <li>5. Christopher M. Bishop**, *Pattern Recognition and Machine Learning*, 1st Edition, Springer, 2006.</li> </ol> |

| Mapping of COs with POs / PSOs |          |          |   |   |          |   |   |   |   |    |          |          |   |
|--------------------------------|----------|----------|---|---|----------|---|---|---|---|----|----------|----------|---|
| COs                            | POs      |          |   |   |          |   |   |   |   |    |          | PSOs     |   |
|                                | 1        | 2        | 3 | 4 | 5        | 6 | 7 | 8 | 9 | 10 | 11       | 1        | 2 |
| 1                              | 3        |          |   |   |          |   |   |   |   |    |          | 1        |   |
| 2                              |          | 3        |   |   |          |   |   |   |   |    |          |          |   |
| 3                              | 3        |          |   |   |          |   |   |   |   |    |          |          |   |
| 4                              |          |          |   |   | 3        |   |   |   |   |    |          | 1        |   |
| 5                              |          |          |   |   |          |   |   |   |   |    | 2        |          |   |
| <b>CO (W.A)</b>                | <b>3</b> | <b>3</b> |   |   | <b>3</b> |   |   |   |   |    | <b>2</b> | <b>1</b> |   |

| 22MEX4I – DIGITAL MANUFACTURING AND IoT        |                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                              |   |   |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                    | L               | T                                            | P | C |
|                                                |                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                    | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                              |   |   |
| Course Objective:                              |                                                                                                                                           | <ul style="list-style-type: none"><li>• To study the various aspects of digital manufacturing.</li><li>• To inculcate the importance of DM in Product Lifecycle Management and Supply chain Management.</li><li>• To formulate of smart manufacturing systems in the digital work environment.</li><li>• To interpret IoT to support the digital manufacturing.</li><li>• To elaborate the significance of digital twin.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                    | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply and Impart knowledge to use various elements in the digital manufacturing.                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                    | Ap              | 20%                                          |   |   |
| CO2                                            | Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment. |                                                                                                                                                                                                                                                                                                                                                                                                                                    | An              | 20%                                          |   |   |
| CO3                                            | Develop the proper procedure of validating practical work through digital validation in Factories.                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                    | An              | 40%                                          |   |   |
| CO4                                            | Explore and Implement the concepts of IoT and its role in digital manufacturing.                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                    | Ap              | 20%                                          |   |   |
| CO5                                            | Evaluate and optimize various practical manufacturing process through digital twin.                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                    | Ap              | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT I - INTRODUCTION TO DIGITAL MANUFACTURING AND IoT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                               | (9) |
| Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing. IoT Sensors – Temperature, Pressure, Gyroscope, Motion detection and proximity.                                                                                                                                                                 |     |
| <b>UNIT II - DIGITAL LIFE CYCLE &amp; SUPPLY CHAIN MANAGEMENT</b>                                                                                                                                                                                                                                                                                                                                                                                                                                           | (9) |
| Collaborative Product Development, Mapping Requirements to specifications – Part Numbering, Engineering Vaulting, and Product reuse – Engineering Change Management, Bill of Material and Process Consistency – Digital Mock up and Prototype development – Virtual testing and collateral. Overview of Digital Supply Chain - Scope& Challenges in Digital SC - Effective Digital Transformation - Future Practices in SCM, New Product Development (NPD) process, stages, test marketing & product launch |     |
| <b>UNIT III - SMART FACTORY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | (9) |
| Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory – Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cyber security – Advanced Simulation Tool – Solid works, MATLAB, SIMUL8, Logisim.                                                                                                                                                                                                                      |     |

|                                                                                                                                                                                                                                                                                                                                                                                                   |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT IV - INDUSTRY 4.0</b>                                                                                                                                                                                                                                                                                                                                                                     | (9) |
| Introduction – Industry 4.0 –Internet of Things – Industrial Internet of Things – Framework: Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics –Cyber physical systems (CPS) –Machine to Machine communication – Case Studies. IoT Applications in Agriculture, Healthcare, Transportation, Hospitality, Smart Grid and Energy saving. |     |
| <b>UNIT V - STUDY OF DIGITAL TWIN</b>                                                                                                                                                                                                                                                                                                                                                             | (9) |
| Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow- Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins.                                                                                                                                                              |     |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                  |     |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <ol style="list-style-type: none"> <li>1. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.</li> <li>2. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, A press, 2016.</li> </ol>                                                                                                                                                                                                                                                                                                                                            |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <ol style="list-style-type: none"> <li>1. Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009.</li> <li>2. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, “Digital Twin Driven Smart Manufacturing”, Elsevier Science., United States, 2019.</li> <li>3. Alp Ustundag and Emre Cevikcan, “Industry 4.0: Managing The Digital Transformation”, Springer Series in Advanced Manufacturing., Switzerland, 2017</li> <li>4. Ronald R. Yager and Jordan Pascual Espada, “New Advances in the Internet of Things”, Springer., Switzerland, 2018.</li> </ol> |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 2                              |     |   |   |   | 3 |   |   |   |   |    | 3  |      |   |
| 3                              |     |   | 3 |   |   | 3 |   |   |   |    |    |      |   |
| 4                              |     |   |   |   |   |   |   |   |   |    |    |      |   |
| 5                              |     |   |   |   |   |   |   |   |   |    |    |      |   |
| CO (W.A)                       | 3   |   | 3 |   | 3 | 3 |   |   |   |    | 3  | 3    |   |



| 22MEX42 - ADDITIVE MANUFACTURING               |                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                     |  |                 |   |                                              |   |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----------------|---|----------------------------------------------|---|
|                                                |                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                     |  | L               | T | P                                            | C |
|                                                |                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                     |  | 3               | 0 | 0                                            | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                     |  |                 |   |                                              |   |
| Course Objective:                              |                                                                                                                                                                                   | <ul style="list-style-type: none"><li>• To introduce the fundamental concepts of Additive Manufacturing (AM) technology and to identify the business opportunities and future directions in AM</li><li>• To understand the role of CAD modeling in AM and the post-processing techniques.</li></ul> |  |                 |   |                                              |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                     |  | Cognitive Level |   | Weightage of COs in End Semester Examination |   |
| CO1                                            | Apply the fundamentals and design principles of additive manufacturing to identify suitable AM processes and optimize part design for real-world applications.                    |                                                                                                                                                                                                                                                                                                     |  | Ap              |   | 20%                                          |   |
| CO2                                            | Apply suitable vat polymerization and directed energy deposition techniques for manufacturing components based on process characteristics, materials and application requirements |                                                                                                                                                                                                                                                                                                     |  | Ap              |   | 20%                                          |   |
| CO3                                            | Apply appropriate powder bed fusion and material extrusion techniques to manufacture components based on material compatibility, process characteristics, and application needs   |                                                                                                                                                                                                                                                                                                     |  | Ap              |   | 20%                                          |   |
| CO4                                            | Apply CAD modeling tools and post-processing techniques to prepare accurate AM-compatible files and improve the quality of printed parts                                          |                                                                                                                                                                                                                                                                                                     |  | Ap              |   | 20%                                          |   |
| CO5                                            | Apply the principles of additive manufacturing processes and technologies to identify suitable methods for creating prototype models for specific applications                    |                                                                                                                                                                                                                                                                                                     |  | C               |   | 20%                                          |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                            |            |
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| <b>UNIT I: FUNDAMENTALS OF ADDITIVE MANUFACTURING AND BUSINESS OPPORTUNITIES</b>                                                                                                                                                                                                                                                                                                                                           | <b>(9)</b> |
| Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling-Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing- Electronics Printing. Business Opportunities and Future Directions –                                                                              |            |
| <b>UNIT II: DESIGN FOR ADDITIVE MANUFACTURING</b>                                                                                                                                                                                                                                                                                                                                                                          | <b>(9)</b> |
| Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization-Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM.                                                                                   |            |
| <b>UNIT III: VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION</b>                                                                                                                                                                                                                                                                                                                                                         | <b>(9)</b> |
| Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP) Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS)- Process - Material Delivery - Materials -Benefits -Applications. |            |

|                                                                                                                                                                                                                                                                                                                                                                                       |            |
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| <b>UNIT IV: POWDER BED FUSION AND MATERIAL EXTRUSION</b>                                                                                                                                                                                                                                                                                                                              | <b>(9)</b> |
| Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations.                                               |            |
| <b>UNIT V: CAD MODELLING AND POST-PROCESSING</b>                                                                                                                                                                                                                                                                                                                                      | <b>(9)</b> |
| CAD Software for AM: AM file format, STL file generation, accuracy of STL files, errors and repairs in STL files, direct and adaptive slicing; Design for additive manufacturing - design for minimum material usage. Post-processing: Support material removal, surface texture improvements, aesthetic improvements, property enhancement using thermal and non-thermal techniques. |            |
| <b>TOTAL= 45PERIODS</b>                                                                                                                                                                                                                                                                                                                                                               |            |

|                                                                                                                                                                                        |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>TEXT BOOKS:</b>                                                                                                                                                                     |  |
| 1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani “Additive manufacturing technologies”. 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0             |  |
| 2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1. |  |
| <b>REFERENCES:</b>                                                                                                                                                                     |  |
| 1. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.         |  |
| 2. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.                   |  |
| 3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.                                               |  |
| 4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States, 2006, ISBN: 978-1-4614-9842-1.                                                      |  |
| 5. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.            |  |

| <b>Mapping of COs with POs / PSOs</b> |            |          |          |          |          |          |          |          |          |           |           |             |          |
|---------------------------------------|------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-------------|----------|
| <b>COs</b>                            | <b>POs</b> |          |          |          |          |          |          |          |          |           |           | <b>PSOs</b> |          |
|                                       | <b>1</b>   | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>6</b> | <b>7</b> | <b>8</b> | <b>9</b> | <b>10</b> | <b>11</b> | <b>1</b>    | <b>2</b> |
| <b>1</b>                              |            |          | 3        | 3        | 3        |          |          |          |          |           |           |             | 3        |
| <b>2</b>                              |            |          |          |          | 3        |          |          |          |          |           |           |             | 3        |
| <b>3</b>                              |            |          | 3        |          | 3        |          |          |          |          |           |           | 3           | 3        |
| <b>4</b>                              |            |          | 3        |          | 3        |          |          |          |          |           |           |             | 3        |
| <b>5</b>                              | 3          |          | 3        |          | 3        |          |          | 3        | 3        |           |           | 3           | 3        |
| <b>CO (W.A)</b>                       | <b>3</b>   |          | <b>3</b> | <b>3</b> | <b>3</b> |          |          | <b>3</b> | <b>3</b> |           |           | <b>3</b>    | <b>3</b> |

| 22MEX43 – GREEN MANUFACTURING DESIGN AND PRACTICES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                      | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | T                                            | P | C   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0                                            | 0 | 3   |
| PREREQUISITE : NIL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |     |
| Course Objective:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                      | <ul style="list-style-type: none"><li>• To familiarize the concept of environmental design and industrial ecology.</li><li>• To impart knowledge of air pollution and its effects on the environment.</li><li>• To emphasize knowledge about noise pollution and its control.</li><li>• To enlighten the students with knowledge about water pollution and its effects on the environment.</li><li>• To emphasize the need of green co-rating and its benefits.</li></ul> |                                              |   |     |
| Course Outcomes<br>The Student will be able to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                      | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Weightage of COs in End Semester Examination |   |     |
| CO1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Apply knowledge on the environmental design and selection of eco-friendly materials. | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |     |
| CO2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Analyze the processes plan minimization for preventing air pollution.                | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |     |
| CO3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Recognize the methods to prevent noise pollution and its hazards                     | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 40%                                          |   |     |
| CO4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Design and develop the impact of water demand and pollutants of water.               | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |     |
| CO5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Evaluate green co-rating and its benefits.                                           | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Internal Assessment                          |   |     |
| UNIT I - DESIGN FOR ENVIRONMENT AND LIFE CYCLE ASSESSMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   | (9) |
| Environmental effects of design - Selection of natural friendly material - Eco design - Environmental damage<br>Material flow and cycles – Material recycling – Emission less manufacturing- Industrial Ecology – Pollution prevention – Reduction of toxic emission – design for recycle.                                                                                                                                                                                                                                                                      |                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |     |
| UNIT II - AIR POLLUTION SAMPLING AND MEASUREMENT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   | (9) |
| Primary and Secondary Pollutants, Automobile Pollutants, Industrial Pollution, Ambient air quality Standards, Metrological aspects of air Pollution, Temperature lapse Rates and Stability-wind velocity and turbulence-Pump behavior dispersion of air Pollutants-solution to the atmosphere dispersion equation-the Gaussian Plume Model, Air pollution sampling-collection of gaseous air pollutants-collection of particulate pollutants-stock sampling, analysis of air pollutants - sulfur dioxide-nitrogen dioxide, carbon monoxide, oxidants and ozone. |                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |     |
| UNIT III - NOISE POLLUTION AND CONTROL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   | (9) |
| Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, Environment and properties, Natural and Anthrogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise, Effects of noise-Occupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects.                                                          |                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |     |
| UNIT IV - WATER DEMAND AND WATER QUALITY                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   | (9) |
| Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non-portable use, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues.                                                                                                                                                                                        |                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |     |

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| <b>UNIT V - GREEN CO-RATING</b>                                                                                                                                                                              | <b>(9)</b> |
| Ecological Footprint - Need For Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage - Assessment Process – Types of Rating – Green Co-Benefits – Case Studies of Green Co-Rating |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                             |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <ol style="list-style-type: none"> <li>1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010</li> <li>2. Rao M.N. and Dutta A.K. “Wastewater treatment”, Oxford &amp; IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <ol style="list-style-type: none"> <li>1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010</li> <li>2. Frances Cairncross– Costing the Earth: The Challenge for Governments, the Opportunities for Business – Harvard Business School Press – 1993.</li> <li>3. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.</li> <li>4. Rao M.N. and Dutta A.K. “Wastewater treatment”, Oxford &amp; IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006</li> <li>5. Rao CS Environmental Pollution Control Engineering-, Wiley Eastern Ltd., New Delhi, 2006.</li> <li>6. Lewis H Bell and Douglas H Bell, Industrial noise control, Fundamentals and applications, Marcel Decker, 1994.</li> </ol> |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              |     |   | 3 |   |   | 3 |   |   |   |    |    | 2    |   |
| 2                              | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 3                              |     |   |   |   |   |   |   |   |   |    | 3  |      |   |
| 4                              |     | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 5                              |     |   |   |   |   |   |   |   |   |    |    |      |   |
| CO (W.A)                       | 3   | 3 | 3 |   |   | 3 |   |   |   |    | 3  | 2    |   |

| 22MEX44 - CASTING AND WELDING PROCESSES        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                              |   |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|
|                                                | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | T               | P                                            | C |
|                                                | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 0               | 0                                            | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                 |                                              |   |
| Course Objective:                              | <ul style="list-style-type: none"><li>• To study the ferrous casting metallurgy and its applications</li><li>• To study the nonferrous casting metallurgy and its applications</li><li>• To study the ferrous welding metallurgy and its applications</li><li>• To study the welding metallurgy of alloy steels and nonferrous metals and its applications</li><li>• To Identifying the causes and remedies of various welding defects; applying welding standards and codes.</li></ul> |                 |                                              |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Cognitive Level | Weightage of COs in End Semester Examination |   |
| CO1                                            | Apply comprehensive knowledge of ferrous and non-ferrous alloys, to effectively contribute to the field of metallurgical engineering.                                                                                                                                                                                                                                                                                                                                                   | Ap              | 20%                                          |   |
| CO2                                            | Apply the principles of alloy selection, melting practices, modification, heat treatment, and defect control in non-ferrous cast alloys for engineering applications.                                                                                                                                                                                                                                                                                                                   | Ap              | 20%                                          |   |
| CO3                                            | Interpret the microstructural changes, phase transformations, and defect mechanisms in welded ferrous alloys to ensure improved weld performance.                                                                                                                                                                                                                                                                                                                                       | Ap              | 20%                                          |   |
| CO4                                            | Examine the welding characteristics, challenges, and remedies in alloy steels and non-ferrous metals to achieve sound welded joints.                                                                                                                                                                                                                                                                                                                                                    | Ap              | 20%                                          |   |
| CO5                                            | Analyze weld defects, weldability issues, and standards to ensure quality and reliability in welded joints.                                                                                                                                                                                                                                                                                                                                                                             | An              | 20%                                          |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |            |
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| <b>UNIT I- FERROUS CAST ALLOYS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>(9)</b> |
| Solidification of pure metals and alloys and eutectics -Nucleation - Growth Process, Critical nucleus size- Super cooling- Niyama Criterion -G/R ratio- Cell- Dendritic - Random dendritic structure-Segregation and Coring- Eutectics-Compositions and alloys in Cast Irons, FG-CGI- SG structures, Metallic Glass- Mold dilation, Mold metal reactions- Structure and Section sensitivity Cast irons- family & microstructures-Alloying effects- Malleable Iron, ADI, Charge calculations- Effect of normal elements and alloying elements in steels- Compositional aspects and properties of alloy steels- melting procedure and composition control for carbon steels- low alloy steels - stainless steels- composition control- slag-metal reactions-desulphurization-dephosphorization, specifications for carbon steels- low alloy steels and stainless steels . |            |
| <b>UNIT II - NON-FERROUS CAST ALLOYS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>(9)</b> |
| Copper- Aluminium- Magnesium- zinc - Nickel base alloys- melting practices - Al alloys, Mg alloys, Nickel alloys, Zinc alloys and copper alloys-modification and grain refinement of Al alloys- problems in composition control- degassing techniques -Heat Treatment of Aluminium alloys – Basics of Solution and Precipitation process. - Applications of Aluminium Alloy castings in various fields. Residual Stresses- defects in castings.                                                                                                                                                                                                                                                                                                                                                                                                                         |            |
| <b>UNIT III - PHYSICAL METALLURGY OF WELDING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>(9)</b> |
| Welding of ferrous materials: Formation of different microstructural zones in welded plain-carbon steels. Welding of C-Mn and low-alloy steels, phase transformations in weld and heat - affected zones, cold cracking, role of hydrogen and carbon equivalent, formation of acicular ferrite and effect on weld metal toughness.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                           |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT IV - WELDING OF ALLOY STEELS AND NON-FERROUS METALS</b>                                                                                                                                                                                                                                                                                                                                                           | <b>(9)</b> |
| Welding of stainless steels, types of stainless steels, overview of joining ferritic and martensitic types, welding of austenitic stainless steels, Sensitisation, hot cracking, sigma phase and chromium carbide formation, ways of overcoming these difficulties, welding of cast iron. Welding of non-ferrous materials: Joining of aluminium, copper, nickel and titanium alloys, problems encountered and solutions. |            |
| <b>UNIT V – DEFECTS, WELDABILITY AND STANDARDS</b>                                                                                                                                                                                                                                                                                                                                                                        | <b>(9)</b> |
| Defects in welded joints: Defects such as arc strike, porosity, undercut, slag entrapment and hot cracking, causes and remedies in each case. Joining of dissimilar materials, weldability and testing of weldments. Introduction to International Standards and Codes.                                                                                                                                                   |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                          |            |

**TEXT BOOKS:**

1. Heine R W, Loper C R and Rosenthal P C, "Principles of Metal Castings", Tata McGraw Hill, 2017
2. A.K.Chakrabarthi, 'Casting Technology and Cast Alloys, Prentice Hall, 2005.

**REFERENCES:**

1. Baldev Raj, Shankar V, Bhaduri A K, "Welding Technology for Engineers", Narosa Publications, 2009.
2. Beeley P, "Foundry Technology" Butterworth-Heinemann, 2001.
3. R.S.Parmar, 'Welding Engineering and Technology', Khanna Publishers, 2010
4. John Campbell, "Casting", Butterworth-Heinemann, 2003.

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    | 2    | 1 |
| 2                              |     | 3 |   |   |   |   |   |   |   |    |    | 2    | 1 |
| 3                              |     |   | 3 |   |   |   |   |   |   |    |    | 2    | 1 |
| 4                              |     | 3 |   |   |   |   |   |   |   |    |    | 2    | 1 |
| 5                              |     |   |   |   |   |   |   |   |   |    | 3  | 2    | 1 |
| CO (W.A)                       | 3   | 3 | 3 |   |   |   |   |   |   |    | 3  | 2    | 1 |



| 22MEX45 – ENVIRONMENT SUSTANABILITY AND IMPACT ASSESSMENT |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |   |   |
|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|---|
|                                                           |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | L                                            | T | P | C |
|                                                           |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 3                                            | 0 | 0 | 3 |
| PREREQUISITE : NIL                                        |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |   |   |
| Course Objective:                                         |                                                                                                       | <ul style="list-style-type: none"><li>• To understand the concepts of Environmental Sustainability &amp; Impact Assessment</li><li>• To familiarize the students in environmental decision making procedure.</li><li>• To identify, predict and evaluate the economic, environmental, and social impact of development activities</li><li>• To provide information on the environmental consequences for decision making</li><li>• To promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.</li></ul> |                                              |   |   |   |
| Course Outcomes<br>The Student will be able to            |                                                                                                       | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Weightage of COs in End Semester Examination |   |   |   |
| CO1                                                       | Apply the concepts of Environment Sustainability and trained to make decision related to Environment. | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |   |   |
| CO2                                                       | Implement lifelong learning skills to make a decision that has an effect on our environment           | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |   |   |
| CO3                                                       | Evaluate the basics of environmental policy, planning and various legislation                         | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |   |   |
| CO4                                                       | Design and optimize the Life cycle assessment of Environmental sustainability.                        | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |   |   |
| CO5                                                       | Analyze the suitable sustainable urban economic development.                                          | An/Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 20%                                          |   |   |   |

|                                                                                                                                                                                                                                                                                                                             |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT I - ENVIRONMENTAL IMPACT ASSESMENT</b>                                                                                                                                                                                                                                                                              | (9) |
| Environmental impact assessment objectives – rationale and historical development of EIA - Conceptual frameworks for EIA Legislative development – European community directive – Hungarian directive. Case studies on air quality, water quality, noise pollution and ecosystem upset.                                     |     |
| <b>UNIT II - ENVIRONMENTAL DECISION MAKING</b>                                                                                                                                                                                                                                                                              | (9) |
| Strategic environmental assessment and sustainability appraisal – Mitigation, monitoring and management of environmental impacts- Socio economic impact assessment. Case Studies on use of transport, making consumer decisions, planning new or improved developments and managing natural resources.                      |     |
| <b>UNIT III - ENVIRONMENTAL POLICY, PLANNING AND LEGISLATION</b>                                                                                                                                                                                                                                                            | (9) |
| Regional spatial planning and policy – Cumulative effects assessment – Planning for climate change, uncertainty and risk. Case studies on Strategy for the Chemical BREFs series review cycle, Carbon Monoxide Emissions from Medium Combustion Plants and Assessment of permitting stringency in industrial installations. |     |
| <b>UNIT IV - LIFE CYCLE ASSESSMENT</b>                                                                                                                                                                                                                                                                                      | (9) |
| Life cycle assessment; Triple bottom line approach; Industrial Ecology. Ecological foot printing, Design for Environment, Future role of LCA, Product stewardship, design, durability and justifiability, measurement techniques and reporting. Life cycle inventory analysis (LCI). Social Life Cycle Assessment (SLCA).   |     |

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| <b>UNIT V - SUSTAINABLE URBAN ECONOMIC DEVELOPMENT</b>                                                                                                                                                                                                                       | <b>(9)</b> |
| Spatial economics – Knowledge economy and urban regions. Case studies on market forces in the development of cities, land use within cities, urban transportation, urban problems and public policy, housing and public policy, and local government expenditures and taxes. |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                             |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <ol style="list-style-type: none"> <li>1. The Application of Science in Environmental Impact Assessment, by Aaron J. MacKinnon, Peter N. Duinker , Tony R. Walker , Routledge; 1st edition (14 May 2019), ISBN-10 : 0367340194</li> <li>2. Routledge Handbook of Environmental Impact Assessment, by Kevin Hanna, Routledge; 1st edition (11 April 2022), ISBN-10 : 0367244470</li> </ol>                                                                                                                                                                                                                                                                                                                              |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <ol style="list-style-type: none"> <li>1. Clive George, C. Collin, H. Kirkpolarice – Impact Assessment and sustainable development – Edward Elgar Publishing, 2007</li> <li>2. Robert B Gibsan, Sustainability Assessment, Earth Scan publishers, 2005</li> <li>3. Simon Dresner, The principle of sustainability – Earth Scan publishers, 2008</li> <li>4. Canter, R.L., “Environmental Impact Assessment”, McGraw Hill Inc., New Delhi, 1996.</li> <li>5. Shukla, S.K. And Srivastava, P.R., “Concepts In Environmental Impact Analysis”, Common Wealth Publishers, New Delhi, 1992.</li> <li>6. John G. Rau And David C Hooten “Environmental Impact Analysis Handbook”, McGraw Hill Book Company, 1990.</li> </ol> |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 2                              |     | 2 |   |   |   |   |   |   |   |    |    | 2    |   |
| 3                              |     |   | 3 |   |   |   |   |   |   |    |    |      |   |
| 4                              |     |   |   |   |   |   |   |   |   |    | 3  |      |   |
| 5                              |     |   |   |   |   | 3 |   |   |   |    |    |      |   |
| CO (W.A)                       | 3   | 2 | 3 |   |   | 3 |   |   |   |    | 3  | 2    |   |





| 22MEX46 - SURFACE ENGINEERING                  |                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                              |   |   |
|------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                |                                                                                                                            | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | T                                            | P | C |
|                                                |                                                                                                                            | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                              |   |   |
| Course Objective:                              |                                                                                                                            | <ul style="list-style-type: none"><li>• To study the fundamentals of surface features and different types of friction associated with metals and non-metals</li><li>• To study the different types of wear mechanism and its standard measurement.</li><li>• To study the different types of corrosion and its preventive measures</li><li>• To study the different types of surface properties and surface modification techniques</li><li>• To study the various types of materials used in the friction and wear applications</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                            | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply the principles of surface characterization and friction to analyze tribological behavior under different conditions. | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 20%                                          |   |   |
| CO2                                            | Analyze wear mechanisms, wear models, and interpret wear debris for performance prediction.                                | A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 20%                                          |   |   |
| CO3                                            | Evaluate corrosion mechanisms and propose effective methods for testing, monitoring, and prevention.                       | E                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 20%                                          |   |   |
| CO4                                            | Assess the suitability of surface treatments and engineering materials for advanced tribological applications.             | E                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 40%                                          |   |   |
| CO5                                            | Create and present a technical report on advanced topics in tribology such as nano-tribology, biomaterials, or coatings.   | C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                        |            |
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| <b>UNIT I - SURFACES AND FRICTION</b>                                                                                                                                                                                                                                                                                                                                                  | <b>(9)</b> |
| Basics of surfaces features – Roughness parameters – surface measurement - Cause of friction- Laws of friction – Static friction – Rolling Friction – Stick-slip Phenomenon - Friction properties of metal and nonmetals – Friction in extreme conditions – Thermal considerations in sliding contact.                                                                                 |            |
| <b>UNIT II - WEAR</b>                                                                                                                                                                                                                                                                                                                                                                  | <b>(9)</b> |
| Laws of Wear - Types of Wear mechanism – wear debris analysis - Theoretical wear models - Wear of metals and nonmetals – International standards in friction and wear measurements                                                                                                                                                                                                     |            |
| <b>UNIT III - CORROSION</b>                                                                                                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Introduction – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors                                                                                        |            |
| <b>UNIT IV - SURFACE TREATMENTS</b>                                                                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Surface properties – Hydrophobic – Super hydrophobic – Hydrophilic - surface metallurgy –Surface coating Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying - New trends in coating technology – DLC – CNC – Thick coatings – Nanoengineered coatings – Other coatings, Corrosion resistant coatings |            |

|                                                                                                                                                                                                                                                                                                                                                                                         |            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT V – ENGINEERING MATERIALS</b>                                                                                                                                                                                                                                                                                                                                                   | <b>(9)</b> |
| Introduction – High and low friction materials - Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Bio Tribology -Nano Tribology                                                                                                                                                      |            |
| <b>TOTAL : 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                               |            |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                      |            |
| 1. G.W .Stachowiak and A.W.Batchelor, “Engineering Tribology”, Butterworth-Heinemann, 2005.<br>2. S.K. Basu, S.N.Sengupta and B.B.Ahuja ,”Fundamentals of Tribology”, Prentice Hall of India, 2005.                                                                                                                                                                                     |            |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                      |            |
| 1. Fontana G., “Corrosion Engineering”, McGraw Hill, 1985.<br>2. H lling, J. (Editor), “Principles of Tribology “, MacMillian, 1984.<br>3. Rabinowicz.E., “Friction and Wear of materials”, John Willey & Sons, 1995.<br>4. Williams J.A., “Engineering Tribology”, Oxford University Press, 1994.<br>5. Joseph R. Davis, Corrosion: Understanding the Basics, ASM International, 2000. |            |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   |   |   |   |   |   |   |   |    |    | 1    |   |
| 2                              | 3   |   |   |   |   |   |   |   |   |    |    | 1    |   |
| 3                              |     | 3 |   |   |   |   |   |   |   |    |    | 1    |   |
| 4                              |     |   | 1 |   |   |   |   |   |   |    |    | 1    |   |
| 5                              |     |   |   |   |   |   |   |   | 1 |    |    | 1    |   |
| <b>CO (W.A)</b>                | 3   | 3 | 1 |   |   |   |   |   | 1 |    |    | 1    |   |

| 22MEX47 – GREEN SUPPLY CHAIN MANAGEMENT        |                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |   |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | T                                            | P | C |
|                                                |                                                                                                                                | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                              |   |   |
| Course Objective:                              |                                                                                                                                | <ul style="list-style-type: none"><li>• To familiar the various standards and legislation of modern green electronic manufacturing.</li><li>• To know the conventional electronic processing and lead-free electronic manufacturing techniques.</li><li>• To recognize the steps involved in assembly process and understand the need of recycle the electronics</li><li>• To implement reliability and product life cycle estimation tools in green electronic manufacturing.</li><li>• To demonstrate the green electronic manufacturing procedure in real time applications.</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply fundamentals to concise awareness of standards and legislation of modern electronic manufacturing for green environment. | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |   |
| CO2                                            | Optimize the conventional electronic processing and lead free electronic manufacturing techniques.                             | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |   |
| CO3                                            | Design and realize the assembly process and the need of recycle in electronics.                                                | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 40%                                          |   |   |
| CO4                                            | Analyze reliability and product life cycle estimation tools for green electronic manufacturing.                                | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 20%                                          |   |   |
| CO5                                            | Validate the green electronic manufacturing procedures in real time applications.                                              | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT I - INTRODUCTION TO GREEN ELECTRONICS</b>                                                                                                                                                                                                                                                                                                                                                                                                              | (9) |
| Environmental concerns of the modern society- Overview of electronics industry and their relevant regulations in China, European Union and other key countries- global and regional strategy and policy on green electronics industry. Restriction of Hazardous substances (RoHS) - Waste Electrical and electronic equipment (WEEE) - Energy using Product (EuP) and Registration - Evaluation, Authorization and Restriction of Chemical substances (REACH). |     |
| <b>UNIT II - GREEN ELECTRONICS MATERIALS AND PRODUCTS</b>                                                                                                                                                                                                                                                                                                                                                                                                      | (9) |
| Basics of IC manufacturing and its process – Electronics with Lead (Pb) – free solder pastes, conductive adhesives, Introduction to green electronic materials and products - halogen-free substrates and components. Substitution of non-recyclable thermosetting polymer based composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous substances in electronic products.                                                    |     |

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| <b>UNIT III - GREEN ELECTRONICS ASSEMBLY AND RECYCLING</b>                                                                                                                                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Various processes in assembling electronics components - the life-cycle environmental impacts of the materials used in the processes - substrate interconnects. Components and process equipments - Technology and management on e-waste recycle system construction, global collaboration, and product disassembles technology. Sustainable Electronics Materials in PCB Manufacturing – Restriction of Hazardous Substances Directive in PCB Assembly. |            |
| <b>UNIT IV - PRODUCT DESIGN AND SUSTAINABLE ECO-DESIGN</b>                                                                                                                                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Stages of product development process in green design: Materials- Manufacturing - Packaging and use - End of Life and disposal - Design for recycling - Life Cycle Assessment (LCA), and Eco-design tools - Environmental management systems, and International standards - Eco-design in electronics industry.                                                                                                                                          |            |
| <b>UNIT V - CASE STUDIES</b>                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>(9)</b> |
| Reliability of green electronics systems , Reuse and recycle of End-of-Life(EOL) electrical and electronic equipment for effective waste management – Introduction of Green Supply Chain, and Modeling green products from Supply Chain point of view - A life-cycle assessment for eco-design of Cathode Ray Tube Recycling. Case studies on Green Supply Chains and Enabling RFID Technology, Healthcare, Aerospace, GSCM and construction industry.   |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                         |            |

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| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <ol style="list-style-type: none"> <li>1. Green Supply Chain Management, by Charisios Achillas , Dionysis D. Bochtis , Dimitrios Aidonis, Routledge; 1st edition (16 November 2018), ISBN-10 : 1138644617</li> <li>2. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.</li> </ol>                                                                                                                                                                                                                                                                                                                                    |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <ol style="list-style-type: none"> <li>1. David Austen, Green Electronic Morning, Ingleby Gallery, 2006.</li> <li>2. John Hu. Mohammed Ismail, CMOS High Efficiency on – Chip Power Management, Springer Publications 4th edition, 2011.</li> <li>3. Yuhang yang and Maode Ma, Green Communications and Networks, Springer Publication., 2014.</li> <li>4. Sanka Ganesan, Michael Pecht, Lead free Electronics, John Wiley &amp; Sons, 2006.</li> <li>5. Charles A. Harper, Electronic Materials and Processes Hand book, McGraw-Hill, 2010.</li> <li>6. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.</li> </ol> |

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              | 3   |   | 3 |   |   |   |   |   |   |    |    | 2    |   |
| 2                              |     |   |   |   |   |   |   |   |   | 3  |    |      |   |
| 3                              |     | 2 |   |   |   | 3 |   |   |   |    |    |      |   |
| 4                              |     |   |   |   |   |   |   |   |   |    |    |      |   |
| 5                              |     |   |   |   |   |   |   |   |   |    |    |      |   |
| CO (W.A)                       | 3   | 2 | 3 |   |   | 3 |   |   |   | 3  |    | 2    |   |

| 22MEX48 - PRODUCT LIFE CYCLE MANAGEMENT        |                                                                                                                                                                                                                                                                                                                                                    |                 |                                              |   |   |
|------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                                                                                                                                                                                                                                    | L               | T                                            | P | C |
|                                                |                                                                                                                                                                                                                                                                                                                                                    | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                                                                                                                                                                                                                                    |                 |                                              |   |   |
| Course Objective:                              | <ul style="list-style-type: none"><li>• To study about the history, concepts and terminology in PLM</li><li>• To learn the functions and features of PLM/PDM</li><li>• To develop different modules offered in commercial PLM/PDM tools</li><li>• To demonstrate PLM/PDM approaches for industrial applications</li><li>• To use PLM/PDM</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                    | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply the concepts and components of Product Lifecycle Management to analyze product evolution stages.                                                                                                                                                                                                                                             | Ap              | 20%                                          |   |   |
| CO2                                            | Apply how changes in global, corporate, and technological environments impact product lifecycle and management.                                                                                                                                                                                                                                    | Ap              | 20%                                          |   |   |
| CO3                                            | Analyze the deployment stages of PLM systems and assess their business benefits in improving productivity and decision-making.                                                                                                                                                                                                                     | An              | 20%                                          |   |   |
| CO4                                            | Assess PLM strategies for services and product management as part of broader business strategy frameworks.                                                                                                                                                                                                                                         | An              | 40%                                          |   |   |
| CO5                                            | Develop and present case studies or applications of PLM in real-world business scenarios including service and digital products.                                                                                                                                                                                                                   | An              | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                    |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - INTRODUCTION TO PRODUCT LIFECYCLE MANAGEMENT</b>                                                                                                                                                                                                                                                       | <b>(9)</b> |
| Introduction to PLM, Fundamentals of PLM- Objective of PLM -Activities of PLM -Joined-up and Holistic Approach - Generic Product Lifecycle Phases, PLM Grid, Components of PLM Grid, Why PLM, How PLM.                                                                                                             |            |
| <b>UNIT II - COMPLEX AND CHANGING ENVIRONMENT</b>                                                                                                                                                                                                                                                                  | <b>(9)</b> |
| Changes and Interconnections, Macroeconomic and Geopolitical Changes, Environmental and Social Changes, Corporate Changes, Technological Changes, Product Changes, The Result and the Requirements                                                                                                                 |            |
| <b>UNIT III - PLM DEPLOYMENT AND BUSINESS BENEFITS</b>                                                                                                                                                                                                                                                             | <b>(9)</b> |
| Deployment Stages of PLM, PLM maturity model, Realization stage of the project, Accomplishing change, Business benefits of a PLM system -Factors leading to PLM, Benefits of the PLM system, Improving the productivity of labour, Costs of quality, PLM and data warehousing as a tool to support decision-making |            |
| <b>UNIT IV - SERVICE INDUSTRY AND PLM</b>                                                                                                                                                                                                                                                                          | <b>(9)</b> |
| Introduction to service, Further productization of services, Making a service, PLM in service business - PLM challenges in service business, Services modularization, Making items out of product functions, IT specifically variable product.                                                                     |            |
| <b>UNIT V - PRODUCT AND PRODUCT MANAGEMENT STRATEGY AS A PART OF BUSINESS STRATEGY</b>                                                                                                                                                                                                                             | <b>(9)</b> |
| Product lifecycle management as a business strategy tool, From changes in the business environment to product strategy, Making a product strategy, Product management strategy, Time to market, Time to react, Time to volume, Time to service, Electronic business and PLM                                        |            |
| <b>TOTAL : 45 PERIODS</b>                                                                                                                                                                                                                                                                                          |            |

**TEXT BOOKS:**

1. John Stark, "Product Lifecycle Management: 21st Century Paradigm for Product Realisation", Springer Publisher, 2011 (2nd Edition).
2. AnttiSaaksvuori and Anselmilmonen, "Product Lifecycle Management", Springer Publisher, 2008 (3rd Edition)

**REFERENCES:**

1. International Journal of Product Lifecycle Management, Inderscience Publishers
2. Ivica Cmkovic, Ulf Asklund and Annita Persson Dahlqvist, "Implementing and Integrating ProductData
3. Management and Software Configuration Management", Art ech House Publishers, 2003.

| Mapping of COs with POs / PSOs |     |   |   |   |   |   |   |   |   |    |    |      |   |
|--------------------------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
| COs                            | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|                                | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1                              |     |   |   |   |   |   |   |   |   |    |    | 1    |   |
| 2                              | 3   |   |   |   |   |   |   |   |   |    |    | 1    |   |
| 3                              |     | 3 |   |   |   |   |   |   |   |    |    | 1    |   |
| 4                              |     |   | 1 |   |   |   |   |   |   |    |    | 1    |   |
| 5                              |     |   |   |   |   |   |   |   | 1 |    |    | 1    |   |
| <b>CO (W.A)</b>                | 3   | 3 | 1 |   |   |   |   |   | 1 |    |    | 1    |   |



| 22MEM01 - BASICS OF ELECTRIC VEHICLES                 |                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |          |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                       |                                                                                                                                                                                                                                                                                                                                                                                     | <b>L</b>               | <b>T</b>                                            | <b>P</b> |
|                                                       |                                                                                                                                                                                                                                                                                                                                                                                     | <b>3</b>               | <b>0</b>                                            | <b>0</b> |
| <b>PREREQUISITE : NIL</b>                             |                                                                                                                                                                                                                                                                                                                                                                                     |                        |                                                     |          |
| <b>Course Objective:</b>                              | <ul style="list-style-type: none"> <li>To introduce learner about EV and its fundamentals.</li> <li>To infer knowledge on electric propulsion technology.</li> <li>To acquire the knowledge on power sources and energy storages.</li> <li>To gain knowledge on hybrid electric vehicle.</li> <li>To understand the principles of fuel cell hybrid electric drive train.</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The student will be able to |                                                                                                                                                                                                                                                                                                                                                                                     | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                   | Apply the principles, technologies, and control strategies to evaluate vehicle performance and to design the efficient EV propulsion systems for sustainable mobility.                                                                                                                                                                                                              | Ap                     | 40                                                  |          |
| CO2                                                   | Apply knowledge of battery types, hybrid energy storage systems, and Battery Management Systems (BMS) to optimize energy solutions for electric vehicle applications.                                                                                                                                                                                                               | Ap                     | 20                                                  |          |
| CO3                                                   | Investigate and compare the operational efficiency and cost-effectiveness of electric vehicles (EVs) with internal combustion engine (ICE) vehicles.                                                                                                                                                                                                                                | An                     | 20                                                  |          |
| CO4                                                   | Analyze solar and fuel cell technologies, along with the design and control strategies of fuel cell hybrid electric drivetrains.                                                                                                                                                                                                                                                    | An                     | 20                                                  |          |
| CO5                                                   | Engage in an independent study as a team and make effective oral presentation on the practical applications of electric vehicles                                                                                                                                                                                                                                                    | Ap                     | Internal Assessment                                 |          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - INTRODUCTION TO ELECTRIC VEHICLES</b>                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Importance of different transportation development strategies to future oil supply - History of EVs – General description of Vehicle movement - Configurations of EVs - Performance of EVs: Traction motor characteristics - Tractive effort and transmission. Requirement - Vehicle performance - Tractive effort in normal driving - Energy consumption, Indian standards for EV.                                                                                          |            |
| <b>UNIT II - ELECTRIC PROPULSION SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>(9)</b> |
| Induction motor drives: Types and working principles, Basic operation principles of induction motors – Motor Torque characteristics, Power electronic control - Field orientation control – Voltage source inverter for FOC - Permanent magnetic BLDC motor drives: Basic principles of BLDC motor drives - BLDC machine. Construction and classification - SRM drives: Basic magnetic structure - Modes of operation - Sensor less control, EESM Technology & Applications. |            |
| <b>UNIT III - ENERGY STORAGES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Electrochemical batteries: Electrochemical reactions - Thermodynamic voltage - Specific energy - Specific power - Energy efficiency. Battery technologies - Lead-acid battery - Nickel-based batteries - Lithium-based batteries - Sodium based batteries - Lithium Ferro Phosphate batteries - Ultra capacitors - Ultra-high-speed flywheels - Hybridization of energy storage. Introduction to BMS.                                                                        |            |

|                                                                                                                                                                                                                                                                                                                                       |            |
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| <b>UNIT IV - HYBRID ELECTRIC VEHICLES</b>                                                                                                                                                                                                                                                                                             | <b>(9)</b> |
| Concept of hybrid electric drive trains - Architectures of EV & hybrid electric drive trains: Series hybrid electric drive trains (Electrical coupling) - Parallel hybrid electric drive trains (Mechanical coupling) - Hybrid drive trains with both torque and speed coupling, Comparison of operating cost of EV and ICE vehicles. |            |
| <b>UNIT V - SOLAR AND FUEL CELL HYBRID ELECTRIC DRIVE TRAIN</b>                                                                                                                                                                                                                                                                       | <b>(9)</b> |
| Solar power technology - Fuel cell technologies - Fuel cell hybrid Electric drive train design: Configuration - Control strategy - Safety aspects in handling EVs & FCEVs, Current challenges in EV adoption.                                                                                                                         |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                      |            |

|                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                         |
| 1. Mehrded Ehsani, Yimin Gao & Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory and Design", 2nd ed., CRC Press, USA, 2017.      |
| <b>REFERENCES:</b>                                                                                                                                                         |
| 1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals", 2nd ed., CRC Press, USA, 2011.                                                                      |
| 2. Chris Mi, Abul Masrur M & David Wenzhong Gao, "Hybrid Electric Vehicles Principles And Applications With Practical Perspectives", 1st ed., Wiley Publication, UK, 2011. |
| 3. Akash Kumar Bhoi, Jens Bo Holm-Nielsen, Nil Patel, Sanjeevikumar Padmanaban, "Electric Vehicles:                                                                        |
| 4. Modern Technologies and Trends (Green Energy and Technology)", Springer, 2020 .                                                                                         |

| CO              | POs      |          |          |          |   |          |          |          |          |    |          | PSOs |   |
|-----------------|----------|----------|----------|----------|---|----------|----------|----------|----------|----|----------|------|---|
|                 | 1        | 2        | 3        | 4        | 5 | 6        | 7        | 8        | 9        | 10 | 11       | 1    | 2 |
| 1               | 3        |          |          |          |   |          |          |          |          |    |          |      |   |
| 2               | 3        |          |          |          |   |          |          |          |          |    |          |      |   |
| 3               |          | 3        | 2        |          |   |          |          |          |          |    |          |      |   |
| 4               |          |          |          | 3        |   |          |          |          |          |    |          |      |   |
| 5               |          |          |          |          |   | 2        | 2        | 1        | 2        |    | 2        |      |   |
| <b>CO (W.A)</b> | <b>3</b> | <b>3</b> | <b>2</b> | <b>3</b> |   | <b>2</b> | <b>2</b> | <b>1</b> | <b>2</b> |    | <b>2</b> |      |   |

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| 22MEM02 - ELECTRIC VEHICLE ARCHITECTURE AND CONTROL SYSTEM |                                                                                                                                                                                                                                                                                                                               |                        |                                                     |          |
|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                            |                                                                                                                                                                                                                                                                                                                               | <b>L</b>               | <b>T</b>                                            | <b>P</b> |
|                                                            |                                                                                                                                                                                                                                                                                                                               | <b>3</b>               | <b>0</b>                                            | <b>0</b> |
| <b>PREREQUISITE : NIL</b>                                  |                                                                                                                                                                                                                                                                                                                               |                        |                                                     |          |
| <b>Course Objective:</b>                                   | <ul style="list-style-type: none"> <li>• To teach the basics of vehicle architecture</li> <li>• To introduce the vehicle mechanics</li> <li>• To provide knowledge on transmission systems and brakes.</li> <li>• To impart the knowledge of plug-in HEV</li> <li>• To introduce the control systems in EV and HEV</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The student will be able to      |                                                                                                                                                                                                                                                                                                                               | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                        | Apply the correct vehicle architectures for the commercial passenger and sports vehicles                                                                                                                                                                                                                                      | Ap                     | 20%                                                 |          |
| CO2                                                        | Analyze the vehicle mechanics like kinetics and dynamics of vehicle motions along with various components                                                                                                                                                                                                                     | An                     | 20%                                                 |          |
| CO3                                                        | Select the transmissions systems and braking systems on EV                                                                                                                                                                                                                                                                    | Ap                     | 20%                                                 |          |
| CO4                                                        | Investigate and compare the working and constructions of plug-in HEV, PHEV, Solar and FCEV                                                                                                                                                                                                                                    | An                     | 40%                                                 |          |
| CO5                                                        | Engage in independent study as a member of team and model the power train components using software                                                                                                                                                                                                                           | Ap                     | Internal Assessment                                 |          |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I – VEHICLE ARCHITECTURE AND SIZING</b>                                                                                                                                                                                                                                                                  | <b>(9)</b> |
| Electric Vehicle History and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures - Mountain Bike - Motorcycle- Electric Cars, Heavy Duty, Sports EVs. - Details and Specifications - Fundamentals of Diode, Bi polar switch, Transistors, Capacitors |            |
| <b>UNIT II – VEHICLE MECHANICS</b>                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Vehicle mechanics - Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire – Road mechanics, Propulsion System Design                                                                                                             |            |
| <b>UNIT III - POWER COMPONENTS AND BRAKES</b>                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Power train Component sizing - Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Examples - Modeling of the components in MATLAB/SIMULINK                                                                                                            |            |
| <b>UNIT IV - PLUG-IN HYBRID ELECTRIC VEHICLE</b>                                                                                                                                                                                                                                                                 | <b>(9)</b> |
| Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV- Block diagram and components – Types of charging, Charging mechanisms-Advantages of PHEVs – FCEV architecture                                                                                    |            |

|                                                                                                                                                                                                                                       |            |
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| <b>UNIT V - SOLAR AND FUEL CELL HYBRID ELECTRIC DRIVE TRAIN</b>                                                                                                                                                                       | <b>(9)</b> |
| Control Design Preliminaries - Introduction – VCU - Transfer Functions – Bode plot analysis, Control of AC machines, Vehicle supervisory control, Mode selection strategy in Hybrid vehicle, Thermal aspects of Electronic components |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                      |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
| <ol style="list-style-type: none"> <li>1. Mehrdad Ehsani, Yimin Gao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.</li> <li>2. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First ed., 2017.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
| <ol style="list-style-type: none"> <li>1. Build Your Own Electric Vehicle, Seth Leitman, Bob Brant, McGraw Hill, Third ed., 2013.</li> <li>2. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011.</li> <li>3. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021</li> <li>4. Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020</li> <li>5. Giancarlo Genta, Lorenzo Morello, "The Automotive Chassis: Volume I: Components Design (Mechanical Engineering Series), Springer, 2nd ed., 2019</li> </ol> |  |

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 2        |     | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 3        | 3   |   | 2 |   | 1 |   |   |   |   |    |    |      |   |
| 4        |     | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 5        |     |   |   |   | 1 | 1 |   |   |   | 1  | 2  |      |   |
| CO (W.A) | 3   | 3 |   |   | 1 | 1 |   |   |   | 1  | 2  |      |   |

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| 22MEM03 - MATERIALS FOR ELECTRIC VEHICLES      |                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                               |                                              |   |   |
|------------------------------------------------|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                |                                                                                                           | L                                                                                                                                                                                                                                                                                                                                                                                                             | T                                            | P | C |
|                                                |                                                                                                           | 3                                                                                                                                                                                                                                                                                                                                                                                                             | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                               |                                              |   |   |
| Course Objective:                              |                                                                                                           | <ul style="list-style-type: none"><li>• To provide the knowledge about the chassis types and materials of the vehicle.</li><li>• To acquire the knowledge of battery types and materials</li><li>• To learn the basic concept of motor, brake and semiconductor materials</li><li>• To study the manufacturing process in the batteries.</li><li>• To understand the basis of materials and testing</li></ul> |                                              |   |   |
| Course Outcomes<br>The student will be able to |                                                                                                           | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                               | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Select the suitable chassis and batteries along with suitable materials for electric vehicles (EVs).      | Ap                                                                                                                                                                                                                                                                                                                                                                                                            | 40%                                          |   |   |
| CO2                                            | Apply the concepts in selecting the suitable material for motors, brakes & semiconductors for EVs.        | Ap                                                                                                                                                                                                                                                                                                                                                                                                            | 20%                                          |   |   |
| CO3                                            | Evaluate the manufacturing processes of EV batteries.                                                     | An                                                                                                                                                                                                                                                                                                                                                                                                            | 20%                                          |   |   |
| CO4                                            | Develop criteria for selecting materials and testing procedures for optimizing EV components performances | An                                                                                                                                                                                                                                                                                                                                                                                                            | 20%                                          |   |   |
| CO5                                            | Conduct investigation on materials for electric vehicles while working as a member of a team/individual   | An                                                                                                                                                                                                                                                                                                                                                                                                            | Internal Assessment                          |   |   |

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| <b>UNIT I - CHASSIS TYPES AND MATERIALS</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Overview of materials, Introduction to chassis, types- Conventional chassis, Non-conventional chassis Full forward chassis, Semi-forward chassis, Bus chassis, Engine at front chassis, Rear chassis and Center chassis Chassis materials, Weightless composite materials                                                                                                                                      |            |
| <b>UNIT II - BATTERIES TYPES AND MATERIALS</b>                                                                                                                                                                                                                                                                                                                                                                 | <b>(9)</b> |
| Types of Batteries, materials- Batteries-Lithium-ion battery & Lead acid battery basics, Special characteristics of lead acid batteries, Battery life and maintenance, Battery charging, Summary, Nickel-based Batteries-Introduction, Nickel cadmium, Nickel metal hydride batteries, battery packaging materials, Battery pack encapsulation materials, fire retardant grade materials, other new materials. |            |
| <b>UNIT III - MATERIALS FOR MOTORS, BRAKES &amp; SEMICONDUCTORS</b>                                                                                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Introduction of motor, types, materials for rotor, stator, body, armature, shaft, bearings, Introduction to brake, types, selection of brake materials. Neodymium permanent magnets, Hydrogen compatible Materials – Metals and Polymers, Semiconductor materials                                                                                                                                              |            |
| <b>UNIT IV - MANUFACTURING OF BATTERIES</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Introduction to manufacturing of batteries, battery production process-electrode manufacturing, mixing, coating & drying, calendaring, slitting, cell assembly-notching, stacking, pouch assembly - Forming, aging and validation.                                                                                                                                                                             |            |

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| <b>UNIT V - MATERIALS AND TESTING</b>                                                                                                                                                                      | <b>(9)</b> |
| Classification of material testing, Purpose of testing, Selection of material, Development of testing, Testing organizations and its committee, Testing standards, Result Analysis, Advantages of testing. |            |
| <b>TOTAL(L:45) = 45 PERIODS</b>                                                                                                                                                                            |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <ol style="list-style-type: none"> <li>1. Vladimir Kobelev, "Design and Analysis of Composite Structures for Automotive Applications Chassis and Drivetrain" Wiley, 2019.</li> <li>2. Austin Hughes, William Drury, "Electric Motors and Drives: Fundamentals, Types and Applications", 4th ed., Newnes, 2013.</li> </ol>                                                                                                                                                                                                                                                                |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <ol style="list-style-type: none"> <li>1. Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th ed., American Society for Metals, 1978.</li> <li>2. Guangjin Zhao, "Reuse and Recycling of Lithium-Ion Power Batteries", John Wiley &amp; Sons, 2017.</li> <li>3. Keisuke Fujisaki, "Magnetic material for motor drive system: fusion technology of electromagnetic fields", Springer, 1st ed., 2019.</li> <li>4. Brian Cantor, P. Grant, C. Johnston, "Automotive engineering: lightweight functional and novel materials", Taylor &amp; Francis, 2008</li> </ol> |

| COs             | POs        |          |          |          |   |   |   |          |          |    |          | PSOs |   |
|-----------------|------------|----------|----------|----------|---|---|---|----------|----------|----|----------|------|---|
|                 | 1          | 2        | 3        | 4        | 5 | 6 | 7 | 8        | 9        | 10 | 11       | 1    | 2 |
| 1               | 3          |          |          |          |   |   |   |          |          |    |          |      |   |
| 2               |            | 3        |          |          |   |   |   |          |          |    |          |      |   |
| 3               |            | 3        |          |          |   |   |   |          |          |    |          |      |   |
| 4               | 2          |          | 3        |          |   |   |   |          |          |    |          |      |   |
| 5               |            |          |          | 2        |   |   |   | 1        | 1        |    | 1        |      |   |
| <b>CO (W.A)</b> | <b>2.5</b> | <b>3</b> | <b>3</b> | <b>2</b> |   |   |   | <b>1</b> | <b>1</b> |    | <b>1</b> |      |   |

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| 22MEM04 - POWERTRAIN DESIGN FOR ELECTRIC VEHICLES |                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                              |   |   |
|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                   |                                                                                                                                                                         | L                                                                                                                                                                                                                                                                                                                                                                                                                                                           | T                                            | P | C |
|                                                   |                                                                                                                                                                         | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                                |                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                              |   |   |
| Course Objective:                                 |                                                                                                                                                                         | <ul style="list-style-type: none"><li>• To introduce the types of structure, construction details and working principle of EV</li><li>• To learn about the design of different electric motor for drives</li><li>• To learn about the various types of transmission systems</li><li>• To acquire knowledge on auxiliary system, steering, brakes and suspension</li><li>• To know the electric vehicles safety and types of advanced technologies</li></ul> |                                              |   |   |
| Course Outcomes<br>The student will be able to    |                                                                                                                                                                         | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                             | Weightage of COs in End Semester Examination |   |   |
| CO1                                               | Apply principles of vehicle construction, aerodynamics, energy systems, and dynamics to design, analyze, and improve electric and hybrid vehicle subsystems effectively | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 20%                                          |   |   |
| CO2                                               | Investigate the various components of electric drive systems and transmission systems for electric vehicles                                                             | An                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 40%                                          |   |   |
| CO3                                               | Analyze the transmission systems and control systems like steering, braking and suspension systems in electric vehicles                                                 | An                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 20%                                          |   |   |
| CO4                                               | Employ the concept of safety systems and advanced technologies in electric vehicles.                                                                                    | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 20%                                          |   |   |
| CO5                                               | Conduct investigation on the power train systems for electric vehicles as a member of a team/individual.                                                                | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                          |            |
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| <b>UNIT I - COMPONENTS OF EV</b>                                                                                                                                                                                                                                                                                                                                         | <b>(9)</b> |
| Vehicle construction - chassis - frame and body - aerodynamics, resistances and Moments – battery – power converter – Electric motor – generator, inverter – Rectifier – coupler – controller – Pure Electric vehicles – Hybrid electric vehicles – Plug in Hybrid Electric vehicle – Vehicle dynamics, Case studies of successful EV models and companies               |            |
| <b>UNITII - ELECTRIC DRIVE SYSTEM</b>                                                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Introduction-Transfer function for DC motor / load and converter – Closed loop control with Current and speed feedback–Armature voltage control and field weakening mode - DC Series Motor - Induction motors - Brushless DC Motor - Permanent Magnet Synchronous Motor (PMSM) - Three Phase AC Induction Motors - Switched Reluctance Motors (SRM) - Torque speed curve |            |
| <b>UNIT III - TRANSMISSION SYSTEM</b>                                                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| E pedal - Electric power converter –Electric booster - power train controller – Driver type - Drive power - Torque converter - Reduction gear-Power split device- driveshaft - differential – axles - Drive wheels                                                                                                                                                       |            |

|                                                                                                                                                                                                                                                                                                                                                                                                               |            |
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| <b>UNIT IV - STEERING, BRAKES AND SUSPENSION SYSTEM</b>                                                                                                                                                                                                                                                                                                                                                       | <b>(9)</b> |
| Principle of steering - steering geometry - steering linkages - steering gear box - power steering - brakes – types and construction - drum brake, disc brake, pneumatic braking system, hydraulic braking system and antilock braking system (ABS) - types of front and rear axle - suspension system - types and construction - coil spring, leaf spring, stabilizer bars - air suspension - shock absorber |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                 |            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT V - SAFETY SYSTEMS &amp; ADVANCED TECHNOLOGY</b>                                                                                                                                                                                                                                                                                                                                                        | <b>(9)</b> |
| Air bags - Electronic Brake Distribution (EBD) - Electronic Stability Program (ESP) - Traction Control System (TCS) - Global Positioning System (GPS) - Collision avoiding system - Tyre pressure monitoring system (TPMS), Cruise controller - driver information system - Advanced driver assistance systems (ADAS), Autonomous vehicles - IoT, Connected cars, Cyber Physical System (CPS) – Safety sensors. |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                |            |

**TEXT BOOKS:**

1. William H. Crouse and Donald L Anglin, “Automotive Mechanics”, 10th ed., McGraw Hill Education (India) Private Limited, 2006.
2. Babu.A.K and Ajit Pal Singh, “Automobile Engineering”, 1st ed., S.Chand Publications, 2013..

**REFERENCES:**

1. Vijayakumar Gali, Luciane Neves Canha, Mariana Resener, Bibiana Ferraz, Madisa V.G. Varaprasad “Advanced Technologies in Electric Vehicles Challenges and Future Research Developments” Academic Press, 1st ed., 2023
2. Marco Mileti, Patrick Strobl, Hermann Pflaum, Karsten Stahl, “Design of a Hyper-High-Speed Powertrain for EV to Achieve Maximum Ranges”, Springer Berlin Heidelberg, 2023
3. Ronald K Jurgen, “Automotive Electronics Handbook”, McGraw Hill, Inc, 1999.
4. Tom Denton, “Automobile Electrical and Electronic Systems”, Edward Arnold publications, 1995
5. Kirpal Singh, “Automobile Engineering Vol.I & 2”, Standard Publishers, New Delhi, 2011

| COs             | POs      |          |   |   |   |          |          |          |          |    |          | PSOs |   |
|-----------------|----------|----------|---|---|---|----------|----------|----------|----------|----|----------|------|---|
|                 | 1        | 2        | 3 | 4 | 5 | 6        | 7        | 8        | 9        | 10 | 11       | 1    | 2 |
| 1               | 3        |          |   |   |   |          |          |          |          |    |          |      |   |
| 2               |          | 3        |   |   |   |          |          |          |          |    |          |      |   |
| 3               |          | 3        |   |   |   |          |          |          |          |    |          |      |   |
| 4               | 3        |          |   |   |   |          |          |          |          |    |          |      |   |
| 5               |          |          |   |   |   | 1        | 2        | 1        | 2        |    | 2        |      |   |
| <b>CO (W.A)</b> | <b>3</b> | <b>3</b> |   |   |   | <b>1</b> | <b>2</b> | <b>1</b> | <b>2</b> |    | <b>2</b> |      |   |

*Signature*

| 22MEM05 - BATTERY MANAGEMENT                          |                                                                                                                                                                                                                                                                                                                                                                                                                                 |                        |                                                     |          |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                       | <b>L</b>                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>T</b>               | <b>P</b>                                            | <b>C</b> |
|                                                       | <b>3</b>                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>0</b>               | <b>0</b>                                            | <b>3</b> |
| <b>PREREQUISITE : NIL</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                                                 |                        |                                                     |          |
| <b>Course Objective:</b>                              | <ul style="list-style-type: none"> <li>To introduce learner about batteries and its parameters</li> <li>To infer knowledge on operational factors of battery technology</li> <li>To acquire the knowledge on lead acid batteries.</li> <li>To understand the battery management system and life prediction of batteries</li> <li>To gain knowledge on traction batteries and miscellaneous applications of batteries</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                   | Identify the various batteries and their operational factors for best suiting to electric vehicles                                                                                                                                                                                                                                                                                                                              | Ap                     | 40%                                                 |          |
| CO2                                                   | Analyze the functioning and use of Li-ion batteries systems and their charging/discharging.                                                                                                                                                                                                                                                                                                                                     | An                     | 20%                                                 |          |
| CO3                                                   | Manage the health of battery and predict the life of battery                                                                                                                                                                                                                                                                                                                                                                    | An                     | 20%                                                 |          |
| CO4                                                   | Interpret the various batteries and their performance for effective use in EV                                                                                                                                                                                                                                                                                                                                                   | An                     | 20%                                                 |          |
| CO5                                                   | Conduct investigation on predicting the battery life for electric vehicles as a member of a team/individual                                                                                                                                                                                                                                                                                                                     | An                     | Internal Assessment                                 |          |

|                                                                                                                                                                                                                                                                                                                                                                                                                              |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT I - INTRODUCTION TO BATTERIES</b>                                                                                                                                                                                                                                                                                                                                                                                    | (9) |
| Types of Batteries - Energy conversion in batteries - Battery components - Principle of operation - Electrode selection - Calculating battery cell voltage - Battery cell voltage and Nernst equation – Cell balancing - Electrolyte for batteries - Gibbs free energy and battery voltage - Theoretical battery capacity - Practical energy of a battery - Specific energy and power, Wireless charging                     |     |
| <b>UNIT II - OPERATIONAL FACTORS OF BATTERY SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                                      | (9) |
| Performance parameters - Battery voltage -Secondary battery systems - Battery limiting factors - Battery current modes of discharge - Discharge current effect on voltage - Discharge current effect on capacity – SOC & SOH -The effect of temperature on battery performance - Self discharge - Calendar and Cycle Life - Internal resistance - safety - Battery selection – Battery testing.                              |     |
| <b>UNIT III - LITHIUM-ION BATTERIES</b>                                                                                                                                                                                                                                                                                                                                                                                      | (9) |
| Introduction - Principle of operation-Types of Lithium-Ion batteries - Cell components and fabrication - Basics of Cell and battery pack design - Failure modes -Charge process - Discharge process – Electrolyte - State of charge (SOC) - Capacity - Cycle life – Self discharge. Applications: Telecommunications and UPS, solar and wind energy storage. Physical and Chemical reactions during charging and discharging |     |

|                                                                                                                                                                                                                                                                                                                                                                        |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| <b>UNIT IV - IV BATTERY MANAGEMENT AND LIFE PREDICTION</b>                                                                                                                                                                                                                                                                                                             | (9) |
| Definitions: Battery management and battery life prediction – Roll of BMS - Monitoring & measuring, SOH - Battery management functions: Charge management, discharge management, safety management and smart battery system - Battery thermal management – Thermal run away - Life Prediction, Recycling of EV Battery, Current trends in battery safety, Case studies |     |
| <b>UNIT V - TRACTION BATTERIES</b>                                                                                                                                                                                                                                                                                                                                     | (9) |
| Introduction to electric vehicles and hybrid electric vehicles - Battery technology for traction: Lead Acid, Nickel Cadmium, Nickel Metal Hydride, Lithium Ion, Lithium Polymer Batteries, Sodium Nickel Chloride Battery. Miscellaneous applications of batteries: Tracking Systems, Toll Collection, Oil Drilling, Car Accessories, Oceanography.                    |     |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                       |     |

| COs             | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|-----------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|                 | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1               | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 2               |     | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 3               |     | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 4               |     | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 5               |     |   |   | 2 |   |   |   | 1 |   |    | 2  |      |   |
| <b>CO (W.A)</b> | 3   | 3 |   | 2 |   |   |   | 1 |   |    | 2  |      |   |

*Praveen*



| 22MEM06 - AI AND IoT FOR ELECTRIC VEHICLES                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                     |                 |                                              |     |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|-----|---|
|                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                     | L               | T                                            | P   | C |
|                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                     | 3               | 0                                            | 0   | 3 |
| PREREQUISITE : NIL                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                     |                 |                                              |     |   |
| Course Objective:                                                                                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"><li>To introduce the fundamentals of IoT</li><li>To introduce learner about AI and its fundamentals</li><li>To impart the knowledge on AI and IoT applications in battery</li><li>To gain knowledge on AI in EV design</li><li>To gain knowledge on recent case studies</li></ul> |                 |                                              |     |   |
| Course Outcomes<br>The student will be able to                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                     | Cognitive Level | Weightage of COs in End Semester Examination |     |   |
| CO1                                                                                                                                                                                                                                                                                                                                                                      | Apply the concepts of IoT & AI in electric vehicles                                                                                                                                                                                                                                                                 | Ap              | 40                                           |     |   |
| CO2                                                                                                                                                                                                                                                                                                                                                                      | Develop a basic AI & IoT systems, to solve a specific problems in battery                                                                                                                                                                                                                                           | Ap              | 20                                           |     |   |
| CO3                                                                                                                                                                                                                                                                                                                                                                      | Apply AI in EV design, manufacturing and power supply for health monitoring of various components                                                                                                                                                                                                                   | An              | 20                                           |     |   |
| CO4                                                                                                                                                                                                                                                                                                                                                                      | Analyze real time applications and use of AI with various case studies                                                                                                                                                                                                                                              | An              | 20                                           |     |   |
| CO5                                                                                                                                                                                                                                                                                                                                                                      | Engage in an independent study as a member of teams / individual and make effective oral presentation in current EV technology with AI & IoT                                                                                                                                                                        | Ap              | Internal Assessment                          |     |   |
| UNIT I - INTRODUCTION TO INTERNET OF THINGS                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                     |                 |                                              | (9) |   |
| Characteristics of IoT, Physical and logical design of IoT - IoT enabling technologies - Wireless sensor networks - Cloud computing - Big data analytics - Communication protocols - Embedded systems - Functional blocks - Communication models and APIS - IoT levels and deployment templates - Overview of microcontroller, sensors and actuators – ESP and Node MCU. |                                                                                                                                                                                                                                                                                                                     |                 |                                              |     |   |
| UNIT II - BASICS OF ARTIFICIAL INTELLIGENCE                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                     |                 |                                              | (9) |   |
| Introduction to AI – Agents and Environments – Concept of rationality – Nature of environments – Structure of agents – Problem solving agents – Search algorithms – Uninformed search strategies – Data management and Data Munging.                                                                                                                                     |                                                                                                                                                                                                                                                                                                                     |                 |                                              |     |   |
| UNIT III - AI AND IoT APPLICATIONS IN BATTERY                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                     |                 |                                              | (9) |   |
| AI and IoT- Based Battery Management System for Electric and Hybrid Electric Vehicles- Monitoring of charging in industrial, commercial, and residential scenarios - health and temperature monitoring, monitoring of key parameters: voltage, current, temperature of battery – Monitoring of individual cells/group of cells.                                          |                                                                                                                                                                                                                                                                                                                     |                 |                                              |     |   |
| UNIT IV - APPLICATIONS OF AI IN EV DESIGN AND POWER SUPPLY                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                     |                 |                                              | (9) |   |
| AI in EV manufacturing, AI in electric vehicle design, modeling and optimization - Self driving EV Controlled with AI - advantages and limitations - AI in power supply management and life cycle assessment, CRISP - DM Method – EV computing system.                                                                                                                   |                                                                                                                                                                                                                                                                                                                     |                 |                                              |     |   |
| UNIT V - CASE STUDIES                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                     |                 |                                              | (9) |   |
| Bosch – Google (Waymo) - Tesla - Autopilot – Audi - Jaguar - Land Rover - Toyota Guardian – FLIR.                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                     |                 |                                              |     |   |
| TOTAL (L:45) = 45 PERIODS                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                     |                 |                                              |     |   |

**TEXT BOOKS:**

1. S. Angalaeswari, T. Deepa, L. Ashok Kumar, "Artificial Intelligence Applications in Battery Management Systems and Routing Problems in Electric Vehicles", IGS Global Publisher, 2023.
2. A. Chitra, P. Sanjeevikumar, Jens Bo Holm-Nielsen, S. Himavath, "Artificial Intelligent Techniques for Electric and Hybrid Electric Vehicles", Wiley online library, 2020.

**REFERENCES:**

1. Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", 4th ed., Pearson Education, 2020.
2. Sudip Misra, Anandarup, Mukherjee, Arijit Roy, "Introduction to IoT", Cambridge University Press, 1st ed., 2022.
3. Arun MR, "Fundamentals of IoT", Notion press, 2022.
4. <https://link.springer.com/book/10.1007/978-981-19-2184-1>.
5. <https://www.researchgate.net/publication/361251263> AI and ML Powered IoT Applications for Energy Management in Electric Vehicles.

| CO              | POs      |          |          |   |   |          |   |          |          |    |          | PSOs |   |
|-----------------|----------|----------|----------|---|---|----------|---|----------|----------|----|----------|------|---|
|                 | 1        | 2        | 3        | 4 | 5 | 6        | 7 | 8        | 9        | 10 | 11       | 1    | 2 |
| 1               | 3        |          |          |   |   |          |   |          |          |    |          |      |   |
| 2               | 3        |          |          |   |   |          |   |          |          |    |          |      |   |
| 3               |          | 3        | 2        |   |   |          |   |          |          |    |          |      |   |
| 4               |          | 3        |          |   |   |          |   |          |          |    |          |      |   |
| 5               |          |          |          |   |   | 1        |   | 1        | 2        |    | 2        |      |   |
| <b>CO (W.A)</b> | <b>3</b> | <b>3</b> | <b>2</b> |   |   | <b>1</b> |   | <b>1</b> | <b>2</b> |    | <b>2</b> |      |   |



| 22MEM07 - AUTONOMOUS VEHICLES                  |                                                                                                                                                                                                                                                                                                                                       |                 |                                              |   |   |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                                                                                                                                                                                                                       | L               | T                                            | P | C |
|                                                |                                                                                                                                                                                                                                                                                                                                       | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                                                                                                                                                                                                                       |                 |                                              |   |   |
| Course Objective:                              | <ul style="list-style-type: none"><li>• To introduce the automated driving</li><li>• To know about the advanced driver assistance systems</li><li>• To learn and understand automated driving technologies</li><li>• To impart the knowledge of social and human issues</li><li>• To learn and under the various case study</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The student will be able to |                                                                                                                                                                                                                                                                                                                                       | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply safety regulations, IMI TechSafe standards, AV automation levels, and ADAS technologies to design and evaluate safe autonomous vehicle systems                                                                                                                                                                                  | Ap              | 40%                                          |   |   |
| CO2                                            | Analyze perception, mapping, connectivity, and AI techniques using LiDAR, V2X, and deep learning to implement automated driving systems                                                                                                                                                                                               | An              | 20%                                          |   |   |
| CO3                                            | Apply global regulation, insurance, public sentiment, and legal frameworks to assess and address autonomous vehicle service challenges.                                                                                                                                                                                               | Ap              | 20%                                          |   |   |
| CO4                                            | Predict practical issues of autonomous vehicles through the analysis of various case studies.                                                                                                                                                                                                                                         | An              | 20%                                          |   |   |
| CO5                                            | Conduct investigation on autonomous vehicles while working as a member of a team/individual and make oral presentation                                                                                                                                                                                                                | Ap              | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                              |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - AUTOMATED DRIVING</b>                                                                                                                                                                                                                                                                            | <b>(9)</b> |
| Introduction to ADV - Safety - Vehicle and its occupants – IMI TechSafe, Regulation and Safety aspects of AV, Levels of automation                                                                                                                                                                           |            |
| <b>UNIT II - ADVANCED DRIVER ASSISTANCE SYSTEMS</b>                                                                                                                                                                                                                                                          | <b>(9)</b> |
| Introduction to ADAS - Example Systems - Adaptive Cruise control - Obstacle Avoidance Radar - Basic reversing aid – Radar - Stereo Video Camera - Rear Radar - Functional Safety and Risk.                                                                                                                   |            |
| <b>UNIT III - AUTOMATED DRIVING TECHNOLOGIES</b>                                                                                                                                                                                                                                                             | <b>(9)</b> |
| Introduction - Road to Autonomy – Perception - Lidar Operation - Sensor Positioning - Automated Driving System – Mapping -Other technologies – Connectivity – Communication for connected vehicles – V2X- Artificial Intelligence - Top-down and Bottom-up AI - Deep learning - End to End Machine Learning. |            |
| <b>UNIT IV - SOCIAL AND HUMAN ISSUES</b>                                                                                                                                                                                                                                                                     | <b>(9)</b> |
| Introduction - Public reaction to CAVs – Insurance - Mobility as a Service - UK - European union – US –Japan and china, External people and property - Service and repair - Legal implications related to Autonomous vehicles, Challenges                                                                    |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT V - CASE STUDIES</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>(9)</b> |
| Nvidia – Bosch - Google (Waymo) - Tesla Autopilot – Nio, Xpeng, Arrival - Audi - Jaguar Land Rover – Toyota Guardian – FLIR - First sensor AG                                                                                                                                                                                                                                                                                                                                                                                                                                |            |
| <b>TOTAL(L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |            |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |
| 1. Tom Denton “Automated Driving and Driver Assistance Systems” 1st ed., Routledge, Taylor & Francis Group, United Kingdom, 2020.                                                                                                                                                                                                                                                                                                                                                                                                                                            |            |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |            |
| 1. Maurer, Markus, J. Christian Gerdes, Barbara Lenz, and Hermann Winner., “Autonomous driving: technical, legal and social aspects” Springer Nature, 2016.<br>2. Coppola, Pierluigi, and Domokos Esztergár-Kiss., “Autonomous Vehicles and Future Mobility”, Elsevier, 2019.<br>3. Hussain T Mouftah, MelikeErol-kantarci and SameshSorour, “Connected and Autonomous Vehicles in Smart Cities” CRC Press, 1st ed., 2020.<br>4. Markus Maurer, J. Christian Gerdes, Barbara Lenz, Hermann Winner, “Autonomou Driving- Technical, Legal and Social Aspects”, Springer, 2016. |            |

| COs             | POs      |            |            |   |   |          |   |          |          |    |          | PSOs |   |
|-----------------|----------|------------|------------|---|---|----------|---|----------|----------|----|----------|------|---|
|                 | 1        | 2          | 3          | 4 | 5 | 6        | 7 | 8        | 9        | 10 | 11       | 1    | 2 |
| 1               | 3        |            |            |   |   |          |   |          |          |    |          |      |   |
| 2               | 3        | 3          |            |   |   |          |   |          |          |    |          |      |   |
| 3               |          | 3          | 2          |   |   |          |   |          |          |    |          |      |   |
| 4               |          | 2          | 3          |   |   |          |   |          |          |    |          |      |   |
| 5               |          |            |            |   |   | 1        |   | 2        | 1        |    | 2        |      |   |
| <b>CO (W.A)</b> | <b>3</b> | <b>2.6</b> | <b>2.5</b> |   |   | <b>1</b> |   | <b>2</b> | <b>1</b> |    | <b>2</b> |      |   |

*Mouftah*

| 22MEM08 - FUEL CELL TECHNOLOGY AND SAFETY REGULATIONS |                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                                              |          |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|----------|
|                                                       |                                                                                                                                                                                                                                                                                                                                                                                                             | <b>L</b>        | <b>T</b>                                     | <b>P</b> |
|                                                       |                                                                                                                                                                                                                                                                                                                                                                                                             | <b>3</b>        | <b>0</b>                                     | <b>0</b> |
| <b>PREREQUISITE : NIL</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                                              |          |
| <b>Course Objective:</b>                              | <ul style="list-style-type: none"> <li>To introduce the working of fuel cells and their types</li> <li>To provide knowledge on fuel cell components and their performance</li> <li>To impart the knowledge on fuel cell and other competing technologies</li> <li>To impart the knowledge of fuel cell applications in automotive field</li> <li>To teach the basics of safety regulations of EV</li> </ul> |                 |                                              |          |
| Course Outcomes<br>The Student will be able to        |                                                                                                                                                                                                                                                                                                                                                                                                             | Cognitive Level | Weightage of COs in End Semester Examination |          |
| CO1                                                   | Interpret the thermodynamics, electrochemical kinetics and working of various types of fuel cells and their components along with fuels for various applications                                                                                                                                                                                                                                            | Ap              | 40%                                          |          |
| CO2                                                   | Analyze the effects of natural gas and hydrogen on SI engine, fuel cell and hybrid electric vehicle through modeling                                                                                                                                                                                                                                                                                        | An              | 20%                                          |          |
| CO3                                                   | Apply the fuel cells for automotive applications along with on-board hydrogen generation and use.                                                                                                                                                                                                                                                                                                           | An              | 20%                                          |          |
| CO4                                                   | Employ the safety regulations of EV and FCEV for various applications                                                                                                                                                                                                                                                                                                                                       | Ap              | 20%                                          |          |
| CO5                                                   | Engage in independent study as a member of team and perform the simulation of the FCEV model using software                                                                                                                                                                                                                                                                                                 | Ap              | Internal Assessment                          |          |

|                                                                                                                                                                                                                                                                                                                      |            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I – INTRODUCTION TO FUEL CELLS</b>                                                                                                                                                                                                                                                                           | <b>(9)</b> |
| Introduction, Introduction – working and types of fuel cell – low, medium and high temperature fuel cell, liquid and methanol types, proton exchange membrane fuel cell - hydrogen types – thermodynamics and electrochemical kinetics of fuel cells.                                                                |            |
| <b>UNIT II - FUEL CELL COMPONENTS AND THEIR IMPACT ON PERFORMANCE</b>                                                                                                                                                                                                                                                | <b>(9)</b> |
| Membrane electrode assembly components, bi-polar plates, humidifiers and cooling plates – current collectors - Fuel cell performance characteristics – current/voltage, voltage efficiency and power density, ohmic resistance, kinetic performance, mass transfer effects, Basics of water and thermal managements. |            |
| <b>UNIT III - FUEL CELL ANALYSIS</b>                                                                                                                                                                                                                                                                                 | <b>(9)</b> |
| Introduction - Modelling of FCEV - Applications to fuel cell and other competing technologies on vehicles - SI engine fueled by natural gas and hydrogen and hybrid electric vehicle.                                                                                                                                |            |
| <b>UNIT IV - FUEL CELLS FOR AUTOMOTIVE APPLICATIONS</b>                                                                                                                                                                                                                                                              | <b>(9)</b> |

Fuel cells for automotive applications – technology advances in fuel cell vehicle systems- onboard hydrogen generation – liquid and compressed hydrogen – metal hydrides, fuel cell control system- road map to market applications.

## **UNIT V - SAFETY REGULATIONS OF EV AND FCEV**

**(9)**

Introduction - EV Policy measures – ARAI standard and Regulations for EV, Electric Power Train Vehicles- Construction and Functional Safety Requirements, Electric Vehicle Charging Safety Guidelines, Charging Infrastructure for Electric Vehicles (EV), Safety Regulations of FCEV, European regulations.

**TOTAL (L:45) = 45 PERIODS**

### **TEXT BOOKS:**

1. Frano Barbir, “ PEM Fuel Cells : Theory and practice”, Elsevier Academic Press, USA, 2005
2. Matthew M. Mench, “Fuel Cell Engines”, John Wiley & Sons, 2008

### **REFERENCES:**

1. Andrew L. Dicks, David A. J. Rand, “Fuel Cell Systems Explained” 3rd Ed., Wiley 2018
2. Pasquale Corbo, Fortunato Migliardini, Ottorino Veneri, “Hydrogen Fuel Cells for Road Vehicles - Green Energy and Technology (GREEN)”, Springer, 2011
3. Gregor Hoogers, “Fuel Cell Technology Handbook” CRC Press, 2003
4. <https://e-vehicleinfo.com/electric-vehicles-in-india-arai-standards-and-regulation/>
5. <https://powermin.gov.in/en/content/electric-vehicle>
6. Viswanathan B, Aulice Scibioh M, “Fuel Cells Principles and Applications”, Universities Press, 2013

| COs         | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|-------------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|             | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1           | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 2           | 3   | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 3           |     | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 4           | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 5           |     |   |   |   | 2 | 1 | 3 | 2 | 1 |    | 2  |      |   |
| CO<br>(W.A) | 3   | 3 |   |   | 2 | 1 | 3 | 2 | 1 |    | 2  |      |   |

*Amber*

| 22GEA02 - PRINCIPLES OF MANAGEMENT             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                                              |   |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|
|                                                | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | T               | P                                            | C |
|                                                | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 0               | 0                                            | 3 |
| PRE-REQUISITE: NIL                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                 |                                              |   |
| Course Objective:                              | <ul style="list-style-type: none"><li>To provide with a foundational understanding of management concepts and practices.</li><li>To equip students with the knowledge and skills necessary to manage and lead organizations effectively, understanding both theoretical frameworks and practical applications in management.</li><li>To learn about various planning tools and decision-making processes crucial for organizational success.</li><li>To gain insights into human resource management functions.</li><li>To study effective communication strategies and the impact of information technology on communication and how effective control can lead to improved productivity and organizational performance.</li></ul> |                 |                                              |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Cognitive Level | Weightage of COs in End Semester Examination |   |
| CO1                                            | Apply key management theories and practices to real-world business scenarios, demonstrating the ability to implement management functions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Ap              | 20%                                          |   |
| CO2                                            | Analyze human resource management practices, evaluating how recruitment, training, performance appraisal, and employee relations contribute to organizational success.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | An              | 20%                                          |   |
| CO3                                            | Evaluate strategic decisions and their impacts on organizational performance, the effectiveness of communication strategies and the use of information technology in facilitating efficient and effective communication within organizations.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | E               | 20%                                          |   |
| CO4                                            | Create comprehensive strategic plans and organizational policies and design control systems to ensure continuous improvement in productivity and organizational performance.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | C               | 20%                                          |   |
| CO5                                            | Engage in independent study as a member of a team and develop higher-order thinking skills that are crucial for effective management and leadership in complex organizational settings with assignments or case studies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Ap              | 20%                                          |   |

|                                                                                                                                                                                                                                                                                                                                                                                             |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I -INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS</b>                                                                                                                                                                                                                                                                                                                                 | <b>(9)</b> |
| Definition of Management - Science or Art - Manager Vs Entrepreneur - types of managers -managerial roles and skills - Evolution of Management - Scientific, human relations, system and contingency approaches - Types of Business organization-Organization culture and Environment - Current trends and issues in Management.                                                            |            |
| <b>UNIT II -PLANNING</b>                                                                                                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Nature and purpose of planning - planning process - types of planning - objectives - setting objectives - policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.                                                                                                                                                          |            |
| <b>UNIT III -ORGANISING</b>                                                                                                                                                                                                                                                                                                                                                                 | <b>(9)</b> |
| Nature and purpose - Formal and informal organization - organization chart - organization structure - types - Line and staff authority - departmentalization -delegation of authority - centralization and decentralization -Job Design - Human Resource Management - HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management |            |

|                                                                                                                                                                                                                                                                                                                     |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT IV - DIRECTING</b>                                                                                                                                                                                                                                                                                          | <b>(9)</b> |
| Foundations of individual and group behaviour - motivation -motivation theories - motivational techniques - job satisfaction - job enrichment - leadership - types and theories of leadership -communication - process of communication - barrier in communication - effective communication -communication and IT. |            |
| <b>UNIT V - CONTROLLING</b>                                                                                                                                                                                                                                                                                         | <b>(9)</b> |
| System and process of controlling - budgetary and non-budgetary control techniques - use of computers and IT in Management control - Productivity problems and management - control and performance -direct and preventive control -reporting.                                                                      |            |
| <b>TOTAL (L:45) : 45 PERIODS</b>                                                                                                                                                                                                                                                                                    |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <ol style="list-style-type: none"> <li>1. Harold Koontz, Heinz Weihrichand Mark V. Cannice "Essentials of Management: An International, Innovation, and Leadership Perspective", 11th Edition, Tata McGraw-Hill Education, 2021.</li> <li>2. J.A.F. Stoner, R.E. Freeman, and Daniel R. Gilbert "Management", 6th Edition, Pearson Education, 2018.</li> </ol>                                                                                                                     |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <ol style="list-style-type: none"> <li>1. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", 6th Edition, Pearson Education, 2004.</li> <li>2. Robert Kreitner &amp; Mamata Mohapatra, "Management", Biztantra, 2008.</li> <li>3. Stephen A. Robbins &amp; David A. Decenzo &amp; Mary Coulter, "Fundamentals of Management", 7th Edition, Pearson Education, 2011.</li> <li>4. Tripathy PC &amp; Reddy PN, "Principles of Management", Tata Mcgraw Hill, 1999.</li> </ol> |

| COs             | POs      |          |          |   |   |   |   |   |          |          |          | PSOs |   |
|-----------------|----------|----------|----------|---|---|---|---|---|----------|----------|----------|------|---|
|                 | 1        | 2        | 3        | 4 | 5 | 6 | 7 | 8 | 9        | 10       | 11       | 1    | 2 |
| 1               | 3        |          |          |   |   |   |   |   |          | 3        |          |      |   |
| 2               |          | 3        |          |   |   |   |   |   |          | 3        |          |      |   |
| 3               |          |          |          |   |   |   |   |   | 3        |          |          |      |   |
| 4               |          |          | 3        |   |   |   |   |   | 3        |          |          |      |   |
| 5               |          |          |          |   |   |   |   |   |          | 3        | 3        |      |   |
| <b>CO (W.A)</b> | <b>3</b> | <b>3</b> | <b>3</b> |   |   |   |   |   | <b>3</b> | <b>3</b> | <b>3</b> |      |   |

*Signature*



| 22GEA03 - TOTAL QUALITY MANAGEMENT                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                        |                                                     |          |
|-------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                       | <b>L</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>T</b>               | <b>P</b>                                            | <b>C</b> |
|                                                       | <b>3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>0</b>               | <b>0</b>                                            | <b>3</b> |
| <b>PREREQUISITE : NIL</b>                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                        |                                                     |          |
| <b>Course Objective:</b>                              | <ul style="list-style-type: none"> <li>To Recognize the importance of quality councils and strategic planning in TQM.</li> <li>To Explore the elements and historical development of TQM.</li> <li>To Foster employee involvement through motivation, empowerment, teamwork, and recognition.</li> <li>To Implement continuous process improvement methods like Juran's Trilogy, PDSA Cycle, 5S, and Kaizen.</li> <li>To Conduct quality audits and understand the introduction to other ISO standards like ISO 14000, IATF 16949, TL 9000, IEC 17025, ISO 18000, ISO 20000, ISO 22000, and ISO 21001.</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| <b>CO1</b>                                            | Describe the elements and principles of Total Quality Management (TQM).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Ap                     | 20%                                                 |          |
| <b>CO2</b>                                            | Apply continuous process improvement methodologies such as Juran's Trilogy, PDSA Cycle, 5S, and Kaizen.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Ap                     | 20%                                                 |          |
| <b>CO3</b>                                            | Apply various quality tools and techniques in both manufacturing and service industry.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Ap                     | 20%                                                 |          |
| <b>CO4</b>                                            | Develop strong supplier partnerships and understand supplier selection, rating, and relationship development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | An                     | 20%                                                 |          |
| <b>CO5</b>                                            | Choose appropriate quality standards and implement them in the respective industry App.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | E                      | 20%                                                 |          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                             |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - QUALITY CONCEPTS AND PRINCIPLES</b>                                                                                                                                                                                                                                                                                                                                                                                                             | <b>(9)</b> |
| Definition of Quality - Dimensions of Quality - Quality Planning - Quality Assurance and Control - Quality Costs with Case Studies - Elements / Principles of TQM - Historical Review - Leadership - Qualities / Habits - Quality Council - Quality Statements, Strategic Planning - Importance - Case Studies - Deming Philosophy - Barriers to TQM Implementation - Cases with TQM Success and Failures.                                                  |            |
| <b>UNIT II - TQM PRINCIPLES AND STRATEGIES</b>                                                                                                                                                                                                                                                                                                                                                                                                              | <b>(9)</b> |
| Customer Satisfaction - Customer Perception of Quality - Customer Complaints - Customer Retention, Employee Involvement - Motivation - Empowerment - Teams - Recognition and Reward - Performance Appraisal, Continuous Process Improvement – Juran's Trilogy - PDSA Cycle - 5S - Kaizen, Supplier Partnership - Partnering - Sourcing - Supplier Selection - Supplier Rating - Relationship Development, Performance Measures - Purpose - Methods - Cases. |            |
| <b>UNIT III - CONTROL CHARTS FOR PROCESS CONTROL</b>                                                                                                                                                                                                                                                                                                                                                                                                        | <b>(9)</b> |
| Basic Seven Tools of Quality and its Role in Quality Control, Statistical Fundamentals - Measures of Central Tendency and Dispersion, Population and Sample - Normal Curve - Control Charts for Variables and Attributes - Process Capability - Case Study- Introduction to Six Sigma.                                                                                                                                                                      |            |

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|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT IV - TQM-MODERN TOOLS</b>                                                                                                                                                                                                                                                                                                                                                                             | <b>(9)</b> |
| New Seven Tools of Quality, Benchmarking - Need - Types and Process, Quality Function Deployment - House of Quality (HOQ) Construction - Case Studies, Introduction to Taguchi's Robust Design - Quality Loss Function - Design of Experiments (DOE), Total Productive Maintenance (TPM) – Uptime Enhancement, Failure Mode and Effect Analysis (FMEA) - Risk Priority Number (RPN) – Process – Case Studies. |            |
| <b>UNIT V - QUALITY SYSTEMS</b>                                                                                                                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Need for ISO 9000 and Other Quality Systems - ISO 9000: 2015 Quality System — Elements - Implementation of Quality System - Documentation - Quality Auditing, Introduction to ISO 14000 - IATF 16949 - TL 9000-IEC 17025 - ISO 18000 - ISO20000 - ISO 22000 - ISO21001. Process of Implementing ISO - Barriers in ISO Implementation.                                                                         |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                              |            |

|                                                                                                                                                                                                 |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOK:</b>                                                                                                                                                                               |
| 1. Besterfield Dale H., Besterfield Carol, Besterfield Glen H., Besterfield Mary, UrdhwaresheHemant, UrdhwaresheRashmi "Total Quality Management", 5th Edition, Pearson Education, Noida, 2018. |
| <b>REFERENCES:</b>                                                                                                                                                                              |
| 1. SubburajRamasamy, "Total Quality Management", McGraw Hill Education, New Delhi, 2017.                                                                                                        |
| 2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, Cengage Learning, 2012.                                                                         |
| 3. David Goetsch& Stanley Davis, "Quality Management for Organizational Excellence: Introduction to Total Quality", 8thEdition,Pearson, 2017.                                                   |

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 2        | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 3        | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 4        |     | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 5        | 3   |   |   |   | 2 |   |   |   |   |    |    |      |   |
| CO (W.A) | 3   | 3 |   |   | 2 |   |   |   |   |    |    |      |   |

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| 22GEA04 - PROFESSIONAL ETHICS                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                                              |   |   |
|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | L               | T                                            | P | C |
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |                                              |   |   |
| Course Objective:                              | <ul style="list-style-type: none"><li>To develop students' ability to identify, analyse, and resolve ethical dilemmas in engineering contexts, fostering a commitment to professional responsibility, integrity, and ethical decision-making.</li><li>To provide engineering students with a comprehensive understanding of ethical principles and practices in the engineering profession.</li><li>To Familiarize students with key ethical theories, principles, and frameworks that guide ethical decision-making in professional practice.</li><li>To Foster the ability to communicate ethical concerns and collaborate effectively with diverse stakeholders, including colleagues, clients, and the public.</li><li>To Encourage students to uphold integrity, honesty, and accountability in their professional activities, fostering a culture of trust and reliability.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply ethical reasoning to evaluate and resolve these issues.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Ap              | 20%                                          |   |   |
| CO2                                            | Apply ethical principles and reasoning to analyze real-world case studies in engineering.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Ap              | 20%                                          |   |   |
| CO3                                            | Analyze the importance of ethics in professional practice.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | An              | 20%                                          |   |   |
| CO4                                            | Develop the ability to make informed and ethical decisions in engineering practice.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | An              | 20%                                          |   |   |
| CO5                                            | Recognize the importance of continuous learning and professional development in maintaining ethical standards.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | E               | 20%                                          |   |   |

|                                                                                                                                                              |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - INTRODUCTION TO PROFESSIONAL ETHICS</b>                                                                                                          | <b>(9)</b> |
| Definition and Importance of Ethics, Ethical Theories and Principles, Ethics vs. Morals vs. Values, Role of Ethics in Engineering.                           |            |
| <b>UNIT II - PROFESSIONAL RESPONSIBILITY AND CODES OF CONDUCT</b>                                                                                            | <b>(9)</b> |
| Professional Responsibility and Accountability, Codes of Conduct in Engineering (e.g., IEEE, NSPE), Conflicts of Interest and Whistle blowing, Case Studies. |            |
| <b>UNIT III - ETHICAL DECISION-MAKING AND PROBLEM-SOLVING</b>                                                                                                | <b>(9)</b> |
| Ethical Decision-Making Models, Tools and Frameworks for Ethical Analysis, Resolving Ethical Dilemmas, Case Studies.                                         |            |
| <b>UNIT IV - LEGAL AND REGULATORY ASPECTS</b>                                                                                                                | <b>(9)</b> |
| Legal Frameworks Governing Engineering Practice, Intellectual Property Rights, Health, Safety, and Environmental Regulations, Case Studies.                  |            |
| <b>UNIT V - SOCIAL AND ENVIRONMENTAL RESPONSIBILITY</b>                                                                                                      | <b>(9)</b> |
| Social Responsibility of Engineers, Sustainable Engineering Practices, Impact of Engineering on Society and Environment, Case Studies.                       |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                             |            |

**TEXT BOOKS:**

1. Charles E. Harris Jr., Michael S. Pritchard, and Michael J. Rabins, "Engineering Ethics: Concepts and Cases" 6th Edition, 2018.
2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", 5th Edition 2010.
3. by M. Govindarajan, S. Natarajan, and V. S. Senthil Kumar, "Professional Ethics and Human Values", 1st Edition 2006.

**REFERENCES:**

1. Stephen H. Unger, "Engineering Ethics: Real-World Case Studies"
2. Online Ethics Center for Engineering and Science - [www.onlineethics.org](http://www.onlineethics.org)
3. National Society of Professional Engineers (NSPE) - [www.nspe.org](http://www.nspe.org)

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 2        | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 3        |     | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 4        |     | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 5        |     |   |   |   |   |   | 3 |   |   |    |    |      |   |
| CO (W.A) | 3   | 3 |   |   |   |   | 3 |   |   |    |    |      |   |



| 22GEZ01- ENTREPRENEURSHIP DEVELOPMENT          |                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                              |   |   |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                                                                                  | L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | T                                            | P | C |
|                                                |                                                                                                                                                                                                  | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 0                                            | 2 | 3 |
| PRE REQUISITE : NIL                            |                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                              |   |   |
| Course Objective:                              |                                                                                                                                                                                                  | <ul style="list-style-type: none"><li>• Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship</li><li>• Apply process of problem –opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects.</li><li>• Analyze market types, conduct market estimation, identify customers, create customer persona, develop the skills to create a compelling value proposition and build a Minimum Viable Product.</li><li>• Explore business models, create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture ideas &amp; solutions built with domain expertise.</li><li>• Prepare and present an investible pitch deck of their practice venture to attract stakeholders.</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                  | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Analyze different types of entrepreneurs and their impact on emerging economies through case studies of successful and failed engineering entrepreneurs                                          | An                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 20%                                          |   |   |
| CO2                                            | Apply concepts related to societal problems, generate and validate ideas, and assess business opportunities by studying emerging markets and their potential                                     | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 20%                                          |   |   |
| CO3                                            | Develop prototypes using various methods and tools, understand their importance in the entrepreneurial process, and iterate based on feedback to enhance their designs                           | C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 20%                                          |   |   |
| CO4                                            | Apply the Lean Canvas to develop business models and craft effective pitches that engage investors and customers                                                                                 | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 20%                                          |   |   |
| CO5                                            | Analyze the entrepreneurial ecosystem, including its components, financing models, and stakeholder networks through interactive activities such as visits and interactions with startup founders | Ap                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 20%                                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                            |              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>MODULE-I: ENTREPRENEURIAL MINDSET</b>                                                                                                                                                                                                                                                                                                                                                                                   | <b>(6+6)</b> |
| <p>Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economics–Developing and Understanding an Entrepreneurial Mindset– Importance of Technology Entrepreneurship – Benefits to the Society.</p> <p>Case Analysis: Study cases of successful &amp; failed engineering entrepreneurs - Foster Creative Thinking: Engage in a series of Problem-Identification and Problem-Solving tasks.</p> |              |
| <b>MODULE- II: OPPORTUNITIES</b>                                                                                                                                                                                                                                                                                                                                                                                           | <b>(6+6)</b> |
| <p>ProblemsandOpportunities–IdeasandOpportunities–Identifyingproblemsinsociety– Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities.</p>                                             |              |

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation – Analyse feedback to refine the opportunity.

**MODULE-III: PROTOTYPING & ITERATION** (6+6)

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques. Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

**MODULE- IV: BUSINESS MODELS & PITCHING** (6+6)

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest assumptions to Business Models – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback.

**MODULE-V: ENTREPRENEURIAL ECOSYSTEM** (6+6)

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowd funding, etc, Support from the government and corporate. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network.

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or maker space or interact with startup founders).

**TOTAL (L:30, P:30) = 60 PERIODS**

**TEXT BOOKS:**

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGraw Hill, 11<sup>th</sup> Edition.
2. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business.

**REFERENCES:**

1. Blank, S.G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch.
2. Roy, R. (2017). Indian Entrepreneurship: Theory and Practice New Delhi: Oxford University Press.
3. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons.

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        |     | 3 |   |   |   |   | 3 | 3 |   | 3  |    |      |   |
| 2        |     | 3 | 3 |   |   | 2 | 3 | 3 |   | 3  |    |      |   |
| 3        |     |   | 3 |   | 3 |   | 3 | 3 |   | 3  |    |      |   |
| 4        |     |   |   |   |   |   | 3 | 3 | 3 | 3  |    |      |   |
| 5        |     |   |   |   |   |   | 3 | 3 | 3 | 3  |    |      |   |
| CO (W.A) |     | 3 | 3 |   | 3 | 2 | 3 | 3 | 3 | 3  |    |      |   |

| 22MEZ01 - VALUE ENGINEERING                    |                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                    |                                              |   |   |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                                                                                  | L                                                                                                                                                                                                                                                                                                                                                                                                                  | T                                            | P | C |
|                                                |                                                                                                                                                                                                  | 3                                                                                                                                                                                                                                                                                                                                                                                                                  | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                    |                                              |   |   |
| Course Objective:                              |                                                                                                                                                                                                  | <ul style="list-style-type: none"><li>To introduce the concept of value engineering for eliminating the unnecessary costs.</li><li>To understand the elements of cost and worth.</li><li>To acquire knowledge on various value engineering techniques.</li><li>To provide awareness about team dynamics and job plan.</li><li>To introduce the financial aspects and human factors of value engineering.</li></ul> |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                  | Cognitive Level                                                                                                                                                                                                                                                                                                                                                                                                    | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply the seven types of values of product using mathematical models and identify the various types and levels of product functions.                                                             | Ap                                                                                                                                                                                                                                                                                                                                                                                                                 | 20%                                          |   |   |
| CO2                                            | Analyze Calculate the cost and price of products by the various elements of cost and evaluate the worth of product with various guidelines.                                                      | An                                                                                                                                                                                                                                                                                                                                                                                                                 | 20%                                          |   |   |
| CO3                                            | Apply Value Engineering techniques effectively, focusing on team building and job plan phases for enhancing value in engineering projects.                                                       | Ap                                                                                                                                                                                                                                                                                                                                                                                                                 | 20%                                          |   |   |
| CO4                                            | Analyze financial metrics such as break-even point, payback period, ROI, and analyze the human aspects in Value Engineering, focusing on ego states and managerial grids for effective teamwork. | An                                                                                                                                                                                                                                                                                                                                                                                                                 | 20%                                          |   |   |
| CO5                                            | Calculate the cost of products with its various components and Analyze the impact of value engineering on ROI, payback period and long-term financial benefits.                                  | An                                                                                                                                                                                                                                                                                                                                                                                                                 | 20%                                          |   |   |

|                                                                                                                                                                                                                                                              |            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I – VALUE AND FUNCTION</b>                                                                                                                                                                                                                           | <b>(9)</b> |
| Seven types values - economic value - cost, use, esteem and exchange values – mathematical model of value - types and levels of functions - function identification - method of finding functions of a product - case study - vocabulary of verbs and nouns. |            |
| <b>UNIT II – COST AND WORTH</b>                                                                                                                                                                                                                              | <b>(9)</b> |
| Cost and price - elements of cost - direct material, direct labour, direct expenses, overheads - calculation of cost - case study - method of determining function cost - evaluation of worth - guidelines to find out worth - value gap and value index.    |            |
| <b>UNIT III – VALUE ENGINEERING TECHNIQUES</b>                                                                                                                                                                                                               | <b>(9)</b> |
| Brainstorming and Gordon techniques - feasibility ranking - morphological analysis technique - ABC analysis - probabilistic approach - make or buy - function-cost-worth analysis - FAST - weighted evaluation method - evaluation matrix - life cycle cost. |            |
| <b>UNIT IV – TEAM DYNAMICS AND JOB PLAN</b>                                                                                                                                                                                                                  | <b>(9)</b> |
| Team structure - team building - physical, intellectual, spiritual transformations - job plan - orientation phase - information phase - function phase - creative phase - evaluation phase - recommendation phase - implementation phase - audit phase.      |            |

**UNIT V – FINANCIAL ASPECTS AND HUMAN RELATION****(9)**

Break-even point - payback period - return on investment - discounted cash flows – balance sheet and profit and loss account - human aspects in value engineering - individual ego states - techniques of transactions - human interactions - Managerial grid.

**TEXT BOOKS:**

1. Mukhophadhyaya A K, “Value Engineering”, 1st ed., Sage Publications Pvt. Ltd., New Delhi, 2003.
2. Mukhophadhyaya A K, “Value Engineering Mastermind”, 1st ed., Sage Publications Pvt. Ltd., New Delhi, 2009.

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1. Richard J Park, “Value Engineering - A plan for inventions”, St.Lucie Press, London, 1998.
2. Iyer. S. S, “Value Engineering: A How to Manual”, 3<sup>rd</sup> ed., New age publishers, 2009.
3. Larry W Zimmesman. P E , “Value Engineering : A Practical approach for owners designers and contractors”, 1<sup>st</sup> ed., CBS Publishers, Delhi, 2010.
4. Theodore C. Fowler, “Value Analysis in Design”, 1<sup>st</sup> ed., SAVE International, 2001.
5. Lawrence D. Miles., “Techniques of Value Analysis and Engineering”, Lawrence D. Miles Value Foundation, 3<sup>rd</sup> Edition, 2015.

| CO       | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | I   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | I    | 2 |
| 1        | 3   |   |   |   |   |   | 3 |   |   |    |    |      |   |
| 2        |     | 3 | 3 |   |   |   | 3 |   |   |    |    |      |   |
| 3        |     |   | 3 |   | 3 | 3 |   |   |   |    |    |      |   |
| 4        |     |   |   |   |   | 3 |   |   |   | 3  |    |      |   |
| 5        |     |   |   |   |   | 3 |   |   |   | 3  |    |      |   |
| CO (W.A) | 3   | 3 | 3 |   | 3 | 3 | 3 |   |   | 3  |    |      |   |



| 22MEZ02 - ERGONOMICS IN DESIGN                 |                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                              |   |   |
|------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                    | L               | T                                            | P | C |
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                    | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                                                                                                                                                                                                                                                                                    |                 |                                              |   |   |
| Course Objective:                              | <ul style="list-style-type: none"><li>• To introduce to industrial design based on ergonomics.</li><li>• To acquire knowledge of ergonomics concept in manufacturing.</li><li>• To understand ergonomics in design of controls and display.</li><li>• To understand environmental factors in ergonomics design.</li><li>• To develop aesthetics applicable to manufacturing and product.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                    | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply the concept of ergonomics in the industrial design.                                                                                                                                                                                                                                                                                                                                          | AP              | 20                                           |   |   |
| CO2                                            | Apply the importance of ergonomics in creation of manufacturing system.                                                                                                                                                                                                                                                                                                                            | AP              | 40                                           |   |   |
| CO3                                            | Design of controls and display in the working environment.                                                                                                                                                                                                                                                                                                                                         | AN              | 20                                           |   |   |
| CO4                                            | Examine the significance of ergonomics in preserving an elevated aesthetic appeal within the manufacturing sector.                                                                                                                                                                                                                                                                                 | AN              | 20                                           |   |   |
| CO5                                            | Engage in an independent study as a team and make effective oral presentation on the practical applications of ergonomics across diverse industrial settings.                                                                                                                                                                                                                                      | AN              | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                     |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - INTRODUCTION</b>                                                                                                                                                                                                                                                                                                                                                                                                        | <b>(9)</b> |
| An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems- Ergonomics and Industrial Design: Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system, Local environment-light, Heat, Sound.                                      |            |
| <b>UNIT II - ERGONOMICS AND PRODUCTION</b>                                                                                                                                                                                                                                                                                                                                                                                          | <b>(9)</b> |
| Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. Visual Effects of Line and Form: The mechanics of seeing, Psychology of seeing, Figure on ground effect, Gestalt's perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form.                                                            |            |
| <b>UNIT III - DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS</b>                                                                                                                                                                                                                                                                                                                                                                        | <b>(9)</b> |
| Displays: Design Principles of visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, Design of multiple displays Controls: Design considerations, Controls with little efforts – Controls with muscular effort. Design of controls in automobiles, Machine Tools. |            |
| <b>UNIT IV - ENVIRONMENTAL FACTORS</b>                                                                                                                                                                                                                                                                                                                                                                                              | <b>(9)</b> |
| Colour: Colour and light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsell colour notation, reactions to colour and colour combination – colour on engineering equipments, Colour coding, Psychological effects, colour and machine form, colour and style.                                                                                         |            |

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| <b>UNIT V – AESTHETIC CONCEPTS</b>                                                                                                                                                                                                                                                                                        | <b>(9)</b> |
| Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good. Introduction to Ergonomic and plant layout software's, total layout design. |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <ol style="list-style-type: none"> <li>1. Ergonomics in Design: Methods and Techniques (Human Factors and Ergonomics) by Marcelo M. Soares, Francisco Rebelo.</li> <li>2. Ergonomics in Product Design by Sendpoints Publishing Co. Ltd.</li> </ol>                                                                                                                                                                                                                                                                                  |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <ol style="list-style-type: none"> <li>1. Benjamin W.Niebel, Motion and Time Study, Richard, D. Irwin Inc., 7thEdition, 2002.</li> <li>2. Bridger, R.C., Introduction to Ergonomics, 2ndEdition, 2003, McGraw Hill Publications.</li> <li>3. Martin Helander, A Guide to human factors and Ergonomics, Taylor and Francis, 2006.</li> <li>4. Brain Shakel, "Applied Ergonomics Hand Book", Butterworth Scientific London 1988.</li> <li>5. Mayall W.H. "Industrial design for Engineers", London Hiffee books Ltd., 1988.</li> </ol> |

| CO              | POs      |   |          |   |   |          |          |   |   |          |    | PSOs |   |
|-----------------|----------|---|----------|---|---|----------|----------|---|---|----------|----|------|---|
|                 | I        | 2 | 3        | 4 | 5 | 6        | 7        | 8 | 9 | 10       | 11 | I    | 2 |
| 1               | 3        |   |          |   |   | 2        |          |   |   |          |    |      |   |
| 2               | 3        |   |          |   |   | 2        |          |   |   |          |    |      |   |
| 3               |          |   | 3        |   |   | 2        |          |   |   |          |    |      |   |
| 4               |          |   | 3        |   |   | 2        | 2        |   |   |          |    |      |   |
| 5               |          |   | 3        |   |   | 2        |          |   |   | 2        |    |      |   |
| <b>CO (W.A)</b> | <b>3</b> |   | <b>3</b> |   |   | <b>2</b> | <b>2</b> |   |   | <b>2</b> |    |      |   |

*Signature*

| 22MEZ03 - INDUSTRIAL SAFETY                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                        |                                                     |          |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------------------------------------------|----------|
|                                                       | <b>L</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>T</b>               | <b>P</b>                                            | <b>C</b> |
|                                                       | <b>3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>0</b>               | <b>0</b>                                            | <b>3</b> |
| <b>PREREQUISITE :NIL</b>                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                        |                                                     |          |
| <b>Course Objective:</b>                              | <ul style="list-style-type: none"> <li>To learn the characteristics of industrial hazards, and demonstrate the ability to assess and mitigate them effectively</li> <li>To study the Factories Act 1948 and other relevant regulations for hazard prevention and fire fighting.</li> <li>To maintenance data, optimize maintenance schedules, and minimize downtime.</li> <li>To study the decision tree models for various types of industrial equipments.</li> <li>To learn the periodic and preventive maintenance plans for different types of industrial equipments.</li> </ul> |                        |                                                     |          |
| <b>Course Outcomes</b><br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>Cognitive Level</b> | <b>Weightage of COs in End Semester Examination</b> |          |
| CO1                                                   | Apply safety measures to prevent industrial accidents and hazards in line with the Factories Act 1948.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Ap                     | 20%                                                 |          |
| CO2                                                   | Analyze the maintenance strategies using engineering principles, data analytics, and machine learning.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | An                     | 20%                                                 |          |
| CO3                                                   | Implement wear and corrosion prevention techniques, including appropriate lubrication methods and corrosion control strategies.                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Ap                     | 20%                                                 |          |
| CO4                                                   | Employ systematic fault tracing methodologies and decision tree analysis for effective diagnostics and fault resolution.                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Ap                     | 20%                                                 |          |
| CO5                                                   | Apply periodic and preventive maintenance programs using CMMS and EAM systems to enhance equipment reliability.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Ap                     | 20%                                                 |          |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I - INDUSTRIAL SAFETY</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>(9)</b> |
| Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Modern fire prevention technologies and firefighting equipment. Role of automation and robotics in industrial safety                                                                            |            |
| <b>UNIT II - MAINTENANCE ENGINEERING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment. Maintenance Optimization through Data Analytics and Machine Learning.                                                                                                                                                    |            |
| <b>UNIT III - WEAR AND CORROSION AND THEIR PREVENTION</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>(9)</b> |
| Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.                                                                                                                                                                                                                                                   |            |
| <b>UNIT IV - FAULT TRACING</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>(9)</b> |
| Fault tracing-concept and importance, decision tree concept, need and applications, Remote monitoring and diagnostics for fault tracing, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes. |            |

| <b>UNIT V - PERIODIC AND PREVENTIVE MAINTENANCE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>(9)</b> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of machineries. Repair cycle concept and importance. Maintenance planning and scheduling optimization using CMMS and EAM systems. |            |
| <b>TOTAL (L:45) = 45 PERIODS</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |            |

**TEXT BOOKS:**

1. L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005.
2. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003

**REFERENCES:**

1. Edward Ghali, V. S. Sastri, M. Elboudjaini, Corrosion Prevention and Protection: Practical Solutions, John Wiley & Sons, 2007.
2. Garg, HP, Maintenance Engineering, S. Chand Publishing.
3. J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017.
4. R. Keith Mobley, Maintenance Fundamentals, Elsevier, 2011.
5. W. E. Vesely, F. F. Goldberg, Fault Tree Handbook, Create space Independent Pub, 2014

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 2        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 3        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 4        | 3   |   |   |   |   |   |   |   |   |    |    | 3    |   |
| 5        |     |   |   |   |   |   | 2 |   |   |    | 2  | 3    |   |
| CO (W.A) | 3   | 3 |   |   |   |   | 2 |   |   |    | 2  | 3    |   |

| 22MEZ04 - PROCESS PLANNING AND COST ESTIMATION |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                 |                                              |   |   |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|----------------------------------------------|---|---|
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | L               | T                                            | P | C |
|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 3               | 0                                            | 0 | 3 |
| PREREQUISITE : NIL                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                 |                                              |   |   |
| Course Objective:                              | <ul style="list-style-type: none"><li>• To introduce the steps involved in Process Planning and computer aided process planning.</li><li>• To acquire knowledge on elements of cost and estimation of cost.</li><li>• To know about the procedure for material cost estimation and weight estimation.</li><li>• To know about the techniques in estimation of time and cost of machining and forging.</li><li>• To introduce the techniques in estimation of time and cost of welding.</li></ul> |                 |                                              |   |   |
| Course Outcomes<br>The Student will be able to |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Cognitive Level | Weightage of COs in End Semester Examination |   |   |
| CO1                                            | Apply CAPP systems to automate and enhance process planning by integrating product data and selecting optimal machining strategies.                                                                                                                                                                                                                                                                                                                                                              | AP              | 20                                           |   |   |
| CO2                                            | Utilize cost estimation procedures to formulate a quantitative assessment of quality output.                                                                                                                                                                                                                                                                                                                                                                                                     | AP              | 40                                           |   |   |
| CO3                                            | Apply estimation methodologies in forging and welding processes to determine their respective costs.                                                                                                                                                                                                                                                                                                                                                                                             | AP              | 20                                           |   |   |
| CO4                                            | Analyse the importance of machining time on quality production in lathe, milling, shaping, planning and grinding.                                                                                                                                                                                                                                                                                                                                                                                | AN              | 20                                           |   |   |
| CO5                                            | Collaboratively conduct an independent study and deliver a compelling oral presentation on designing an effective process planning.                                                                                                                                                                                                                                                                                                                                                              | AN              | Internal Assessment                          |   |   |

|                                                                                                                                                                                                                                                                                                                     |            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>UNIT I – PROCESS PLANNING</b>                                                                                                                                                                                                                                                                                    | <b>(9)</b> |
| Product design and analysis - process selection, planning, steps involved, responsibilities of process planning engineer - steps involved in product design - process design – steps in process selection - variant and generative process planning.                                                                |            |
| <b>UNIT II - ELEMENTS OF COST AND COST ESTIMATION</b>                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Classification of costs - Cost estimation - functions of cost estimate - costing - types of estimates - methods of cost estimation - variations in cost estimates - data needed and data sources - estimating procedure - selling price - estimation of labor cost, material cost - allocation of overhead charges. |            |
| <b>UNIT III - MATERIAL COST AND WEIGHT ESTIMATION</b>                                                                                                                                                                                                                                                               | <b>(9)</b> |
| Steps of estimating material cost - mensuration - area and perimeter, areas of irregular shapes, volume and surface area of solids, centroid, surface areas using centroid, volume of solid of revolution - material weight and cost estimation - steps involved.                                                   |            |
| <b>UNIT IV - ESTIMATION OF MACHINING TIME</b>                                                                                                                                                                                                                                                                       | <b>(9)</b> |
| Estimation of machining time - importance of machine time calculation - calculation of machining time for different lathe operations, drilling and boring - machining time calculation for milling, shaping and planning - machining time calculation for grinding.                                                 |            |
| <b>UNIT V – ESTIMATION OF FORGING AND WELDING COST</b>                                                                                                                                                                                                                                                              | <b>(9)</b> |
| Forging - types of forging - forging operations - losses in forging - estimation of forging cost - Welding - terminologies - types of welding - fusion and pressure welding - types of welded joints - techniques of welding - leftward and rightward welding, estimation of welding cost.                          |            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |  |  |  |  |  |  |  |  |  |  |  |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|--|--|--|--|--|--|--|--|
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Gideon Halevi, "Process and operation planning", 2nd ed., Springer-Verlag New York, 2003.<br>2. Panneerselvam R, "Process Planning and Cost Estimation", Prentice-Hall of India Pvt.Ltd, 2016.                                                                                                                                                                                                                                                                                                         |  |  |  |  |  |  |  |  |  |  |  |  |  |
| <b>REFERENCES:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 1. Adithan.M, "Process Planning and Cost Estimation", New Age International Publishers, 2015.<br>2. Peter Scallan, "Process planning, The Design/Manufacture interface", Butterworth-Heinemann, 2003.<br>3. G.B.S. Narang, V. Kumar, "Production and Costing", Khanna Publishers, 2000.<br>4. Peter scalon, "Process planning, Design/Manufacture Interface", Elsevier science technology Books, Dec 2002.<br>5. Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002. |  |  |  |  |  |  |  |  |  |  |  |  |  |

| COs      | POs |   |   |   |   |   |   |   |   |    |    | PSOs |   |
|----------|-----|---|---|---|---|---|---|---|---|----|----|------|---|
|          | 1   | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 1    | 2 |
| 1        | 3   |   |   |   |   |   |   |   |   |    |    |      |   |
| 2        |     | 3 |   |   |   |   |   |   |   |    |    |      |   |
| 3        |     |   |   | 2 | 2 |   |   |   |   | 2  |    |      |   |
| 4        |     |   | 2 | 2 |   |   |   |   |   |    |    |      |   |
| 5        |     |   |   |   |   |   |   | 1 |   | 1  | 1  |      |   |
| CO (W.A) | 3   | 3 | 2 | 2 | 2 |   |   | 1 |   | 1  | 1  |      |   |

*Signature*