B. Tech.

MECHANICAL ENGINEERING

FLEXIBLE CURRICULUM

(For students admitted in 2019-2020 onwards)

DEPARTMENT OF MECHANICAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015
TAMIL NADU, INDIA
# Department of Mechanical Engineering, National Institute of Technology, Tiruchirappalli

## INSTITUTE VISION

To be a university globally trusted for technical excellence where learning and research integrate to sustain society and industry.

## INSTITUTE MISSION

1. To offer undergraduate, postgraduate, doctoral and modular programmes in multi-disciplinary / inter-disciplinary and emerging areas.
2. To create a converging learning environment to serve a dynamically evolving society.
3. To promote innovation for sustainable solutions by forging global collaborations with academia and industry in cutting-edge research.
4. To be an intellectual ecosystem where human capabilities can develop holistically.

## DEPARTMENT VISION

To be a globally renowned Department in Mechanical Engineering where the best of teaching, learning and research synergize to fulfil the requirements of industry and society.

## DEPARTMENT MISSION

1. To prepare effective and responsible engineers for global requirements by providing quality education through graduate, post graduate and doctoral research programmes.
2. To constantly strive to improve the teaching and learning processes by adopting innovative pedagogical methods.
3. To respond effectively to the needs of the industry and society by offering sustainable and innovative solutions
4. To conduct basic and interdisciplinary research to publish in reputed international journal and to generate intellectual property.
5. To provide consultancy services and cultivate the spirit of entrepreneurship.
Programme Educational Objectives (PEO's)

1. Graduates will be successful Mechanical Engineers in the industry or in technical or professional career.
2. Graduates will continue to constantly learn the emerging technology and advanced field of study.
3. Graduates will be able to take up leadership positions in interdisciplinary technological activities.

Programme Outcomes (Pos)

1. Apply knowledge of mathematics, science and engineering to arrive solutions for mechanical engineering problems.
2. Identify, formulate and analyze engineering problems through technical literature.
3. Design a component, a process and a system to meet desired needs considering economic, environmental, social, ethical, health and safety, manufacturability and sustainability.
4. Conduct experiment, analyze and interpret data to arrive valid conclusions.
5. Use the techniques, skills, and modern engineering tools for modelling and prediction of problems by understanding the limitations.
6. Recognize the importance of health and safety, societal, cultural responsibility in the design and implementation of engineering projects.
7. Know and apply societal and environmental context to engineering solutions for sustainable development.
8. Apply the standards and professional ethics in engineering practice.
9. Function effectively as a member or leader of a team.
10. Express effectively, comprehend and write reports on the engineering activities.
11. Apply engineering and management principles to manage projects in multidisciplinary environments.
12. Engage themselves in life-long learning by recognizing the need and technological changes.
Programme Specific Outcomes (PSOs)

1. Apply the fundamental knowledge acquired in the area of design, thermal engineering and manufacturing to identify, formulate and solve mechanical engineering problems confronted by the industry and society.

2. Develop products and processes by carrying out research and development considering the economic constraints, sustainability, environment, safety, and cultural perceptions.
The total minimum credits for completing B.Tech. Programme in Mechanical Engineering is 158.

**MINIMUM CREDIT REQUIREMENT FOR THE VARIOUS COURSE CATEGORIES**

The structure of B.Tech. Programme shall have General Institute Requirements (GIR), Programme Core (PC), Elective Courses (PE and OE), Minor (MI) Courses, Honours (HO) Courses and Essential Laboratory Requirement (ELR) Courses are as follows:

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Category</th>
<th>No. of Courses</th>
<th>No. of Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>General Institute Requirement (GIR) Courses</td>
<td>22</td>
<td>50</td>
</tr>
<tr>
<td>2.</td>
<td>Programme Core (PC) Courses</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>3.</td>
<td>Essential Laboratory Requirement (ELR) Courses</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>4.</td>
<td>Elective Courses</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a. Programme Elective (PE)</td>
<td>14*</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>b. Open Elective (OE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Minor (MI) Course (Optional)</td>
<td>Courses for 15 credits</td>
<td>Additional 15 credits</td>
</tr>
<tr>
<td>6.</td>
<td>Honors (HO) Course (Optional)</td>
<td>Courses for 15 credits</td>
<td>Additional 15 credits</td>
</tr>
</tbody>
</table>

*Out of 14 elective courses, eight should be Program Elective (PE) courses. Out of the remaining six electives, a student can opt for Project Work instead of two electives equivalent to 6 credits.*
### I. GENERAL INSTITUTE REQUIREMENT (GIR) COURSES:

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of the Course</th>
<th>No. of Courses</th>
<th>Max. Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mathematics</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>2.</td>
<td>Physics (Theory and Lab)</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>3.</td>
<td>Chemistry (Theory and Lab)</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>4.</td>
<td>Industrial Economics and Foreign Trade</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>English for Communication (Theory &amp; Lab)</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>Energy and Environmental Engineering</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>Professional Ethics</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>Engineering Graphics</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>9.</td>
<td>Engineering Practice</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>Basic Engineering</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>11.</td>
<td>Introduction to computer Programming</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td>Branch Specific Course (Introduction to Mechanical Engineering)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>13.</td>
<td>Summer Internship</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>14.</td>
<td>Comprehensive viva</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>15.</td>
<td>Industrial Lecture</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>16.</td>
<td>NSS/NCC/NSO (Compulsory Participation)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>17.</td>
<td>Project Work</td>
<td>1**</td>
<td>6**</td>
</tr>
</tbody>
</table>

**Project work is an optional course. A student can opt for either Project Work or two electives courses equivalent to 6 credits

### 1. MATHEMATICS

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MAIR11</td>
<td>Matrices and Calculus</td>
<td>-NIL-</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>MAIR21</td>
<td>Complex Analysis and Differential Equations</td>
<td>-NIL-</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>MAIR43</td>
<td>Fourier transforms and Numerical techniques</td>
<td>MAIR11, MAIR21</td>
<td>4</td>
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2. **PHYSICS**

<table>
<thead>
<tr>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>PHIR11</td>
<td>Physics</td>
<td>-NIL-</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>PHIR12</td>
<td>Physics Lab</td>
<td>-NIL-</td>
<td>2</td>
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3. **CHEMISTRY**

<table>
<thead>
<tr>
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<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CHIR11</td>
<td>Chemistry</td>
<td>-NIL-</td>
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<tr>
<td>2.</td>
<td>CHIR12</td>
<td>Chemistry Lab</td>
<td>-NIL-</td>
<td>2</td>
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<td><strong>Total</strong></td>
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4. **HUMANITIES**

<table>
<thead>
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<th>Pre-requisites</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1.</td>
<td>HSIR11</td>
<td>English for Communication</td>
<td>-NIL-</td>
<td>2</td>
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<tr>
<td></td>
<td></td>
<td>Language Lab</td>
<td>-NIL-</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>HSIR13</td>
<td>Industrial Economics and Foreign Trade</td>
<td>-NIL-</td>
<td>3</td>
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<tr>
<td>3.</td>
<td>HSIR14</td>
<td>Professional Ethics</td>
<td>-NIL-</td>
<td>3</td>
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<td></td>
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<td><strong>Total</strong></td>
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5. **ENERGY AND ENVIRONMENTAL ENGINEERING**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ENIR11</td>
<td>Energy and Environmental Engineering</td>
<td>-NIL-</td>
<td>2</td>
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<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
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### 6. ENGINEERING GRAPHICS

<table>
<thead>
<tr>
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<th>Pre-requisites</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>MEIR12</td>
<td>Engineering Graphics</td>
<td>-NIL-</td>
<td>3</td>
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</table>

**Total** 3

### 7. ENGINEERING PRACTICE

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>PRIR11</td>
<td>Engineering Practice</td>
<td>-NIL-</td>
<td>2</td>
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</table>

**Total** 2

### 8. BASICS OF ENGINEERING

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>EEIR11</td>
<td>Basics of Electrical and Electronics Engineering</td>
<td>-NIL-</td>
<td>2</td>
</tr>
<tr>
<td>2.</td>
<td>CEIR11</td>
<td>Basics of Civil Engineering</td>
<td>-NIL-</td>
<td>2</td>
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</table>

**Total** 4

### 9. COMPUTER PROGRAMMING

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CSIR11</td>
<td>Introduction to Computer Programming</td>
<td>-NIL-</td>
<td>3</td>
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</table>

**Total** 3

### 10. BRANCH SPECIFIC COURSE

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MEIR15</td>
<td>Introduction to Mechanical Engineering</td>
<td>-NIL-</td>
<td>2</td>
</tr>
</tbody>
</table>

**Total** 2
11. SUMMER INTERNSHIP

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MEIR16</td>
<td>Summer Internship</td>
<td>-NIL</td>
<td>2</td>
</tr>
</tbody>
</table>

Total 2

Students should undergo industrial training/internship for a minimum period of six weeks during the summer vacation of III year. Registration for this course shall be along with the courses for VII semester. Attachment with an academic institution within the country (IISc/IITs/NITs/IIITs and CFTIs) or university abroad is also permitted instead of industrial training. A report is to be submitted to the Head of the Department and evaluation (2 credit) will be based on the report and viva-voce examination.

12. PROJECT WORK

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MEIR17</td>
<td>Project Work#</td>
<td>-NIL-</td>
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</tbody>
</table>

Total 6

13. COMPREHENSIVE VIVA

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MEIR18</td>
<td>Comprehensive Viva</td>
<td>NIL-</td>
<td>1</td>
</tr>
</tbody>
</table>

Total 1

The comprehensive examination in the final year of study shall have two objective tests of 25 marks each. The final examination shall have 50 marks. The examination will be of objective type similar to the GATE examination. A department committee comprising the Head of the Department or his/her nominee and two faculty members of the department shall conduct the examinations.
14. **INDUSTRIAL LECTURE**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MEIR19</td>
<td>Industrial Lecture</td>
<td>-NIL-</td>
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<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>1</strong></td>
</tr>
</tbody>
</table>

A course based on industrial lectures shall be offered for 1 credit. A minimum of five lectures of two hours’ duration by industry experts will be arranged by the Department. The evaluation methodology will in general be based on quizzes at the end of each lecture. Due weightage shall be given to attendance also. However, the HoD or her/his nominee may devise a suitable methodology for evaluation and the same should be informed to the students before the commencement of the semester.

15. **NSS/NCC/NSO**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>SWIR11</td>
<td>NSS / NCC / NSO</td>
<td>-NIL-</td>
<td>0</td>
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<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
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<td><strong>0</strong></td>
</tr>
</tbody>
</table>

All students admitted to the B.Tech. Program will have to take either NCC or NSO or NSS as a non-credit extra-curricular Program. NCC Program is not available for foreign nationals. The NCC / NSO / NSS requirement should be completed within the first two semesters.
II. **PROGRAMME CORE (PC) COURSES**

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MEPC10</td>
<td>Engineering Mechanics</td>
<td>-NIL-</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>MEPC11</td>
<td>Engineering Thermodynamics</td>
<td>-NIL-</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>MEPC12</td>
<td>Strength of Materials</td>
<td>-NIL-</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>MEPC13</td>
<td>Applied Electrical and Electronics Engineering</td>
<td>EEIR11</td>
<td>4</td>
</tr>
<tr>
<td>5.</td>
<td>MEPC14</td>
<td>Fluid Mechanics and Machines</td>
<td>-NIL-</td>
<td>4</td>
</tr>
<tr>
<td>6.</td>
<td>MEPC15</td>
<td>Mechanics of Machines – I</td>
<td>MEPC10</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>MEPC16</td>
<td>Manufacturing Technology</td>
<td>-NIL-</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>MEPC17</td>
<td>Thermal Engineering</td>
<td>MEPC11</td>
<td>4</td>
</tr>
<tr>
<td>9.</td>
<td>MEPC18</td>
<td>Engineering Materials</td>
<td>-NIL-</td>
<td>4</td>
</tr>
<tr>
<td>10.</td>
<td>MEPC19</td>
<td>Heat and Mass Transfer</td>
<td>MEPC11</td>
<td>3</td>
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<tr>
<td>11.</td>
<td>MEPC20</td>
<td>Mechanics of Machines – II</td>
<td>MEPC15</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td>MEPC21</td>
<td>Metrology and Measurements</td>
<td>-NIL-</td>
<td>3</td>
</tr>
<tr>
<td>13.</td>
<td>MEPC22</td>
<td>Automobile Engineering</td>
<td>-NIL-</td>
<td>3</td>
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<tr>
<td>14.</td>
<td>MEPC23</td>
<td>Energy Conversion systems</td>
<td>MEPC17</td>
<td>3</td>
</tr>
<tr>
<td>15.</td>
<td>MEPC24</td>
<td>Design of Machine Elements</td>
<td>MEPC12, MEPC15</td>
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</table>
### ESSENTIAL LABORATORY REQUIREMENT (ELR) COURSES

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MELR11</td>
<td>Strength of Materials and Fluid Mechanics &amp; Machines Laboratory</td>
<td>-NIL-</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>MELR13</td>
<td>Thermal Engineering Laboratory</td>
<td>-NIL-</td>
<td>2</td>
</tr>
<tr>
<td>4.</td>
<td>MELR14</td>
<td>Manufacturing Technology Laboratory</td>
<td>-NIL-</td>
<td>2</td>
</tr>
<tr>
<td>5.</td>
<td>MELR15</td>
<td>Heat Transfer and Refrigeration &amp; Air-Conditioning Laboratory</td>
<td>-NIL-</td>
<td>2</td>
</tr>
<tr>
<td>6.</td>
<td>MELR16</td>
<td>Metrology and Measurements Laboratory</td>
<td>-NIL-</td>
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<td>7.</td>
<td>MELR17</td>
<td>Dynamics Laboratory</td>
<td>-NIL-</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>MELR18</td>
<td>Automobile Engineering Laboratory</td>
<td>-NIL-</td>
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IV. **ELECTIVE COURSES**

a. **PROGRAMME ELECTIVES (PE)**

Out of the 14 elective courses offered in the curriculum, a Student should opt for a minimum eight Program Elective courses.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MEPE10</td>
<td>Compressible Flow and Jet Propulsion</td>
<td>MEPC14</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>MEPE11</td>
<td>Computational Fluid Dynamics</td>
<td>MEPC14</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>MEPE12</td>
<td>Advanced IC Engines</td>
<td>MEPC17</td>
<td>3</td>
</tr>
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## V. MINOR COURSES

MI –Minor Degree: 15 credits over and above the minimum credit as specified by the departments. The details of MINOR will be mentioned only in the transcript not in the Degree certificate.

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VI. HONORS COURSE

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### Semester II

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<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MEIR16</td>
<td>Summer Internship</td>
<td>-NIL-</td>
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<td>Elective VIII</td>
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<td>3.</td>
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<tr>
<td>5.</td>
<td></td>
<td>Elective XI</td>
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</table>

**TOTAL CREDITS** 14

### Semester VIII

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Pre-requisites</th>
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<tbody>
<tr>
<td>1.</td>
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<td>Comprehensive Viva Voce</td>
<td>-NIL-</td>
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<tr>
<td>2.</td>
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<td>Elective XII</td>
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<td></td>
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<tr>
<td>5.</td>
<td></td>
<td>Project Work**</td>
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<td>6**</td>
</tr>
</tbody>
</table>

**TOTAL CREDITS** 10

**Project work is an optional course. A student can opt for either Project Work or two electives courses equivalent to 6 credits**
MAIR11 MATRICES AND CALCULUS

**Course Code:** MAIR11

**No. of Credits:** 03

**Course Name:** Matrices and Calculus

**Prerequisite:** Nil

**COURSE LEARNING OBJECTIVES**

- Introduce eigen value and eigen vectors and its properties.
- Determine canonical form of given quadratic form.
- Discuss the convergence of infinite series.
- Analyse and discuss the extrema of the functions of several variables.
- Evaluate the multiple integrals and apply in solving problems.
- Introduce vector differential operator for vector function and important theorems on vector functions to solve engineering problems.

**COURSE CONTENT**

Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem. Quadratic form.

Sequence and series: Convergence of sequence. Infinite Series-Tests for Convergence-Integral test, comparison test, Ratio test, Root test, Raabe’s test, Logarithmic test, and Leibnitz’s test; Power series.

Functions of two variables: Limit, continuity and partial derivatives; Total derivative, Jacobian, Taylor series, Maxima, minima and saddle points; Method of Lagrange multipliers; Double and triple integrals, change of variables, multiple integral in cylindrical and spherical coordinates.

Gradient, divergence and curl; Line and surface integrals; Green's theorem, Stokes theorem and Gauss divergence theorem (without proofs).

**REFERENCE BOOKS**

COURSE OUTCOME

1. Compute eigenvalues and eigenvectors of the given matrix.
2. Transform given quadratic form into canonical form.
3. Discuss the convergence of infinite series by applying various tests.
4. Compute partial derivatives of function of several variables.
5. Write Taylor's series for functions with two variables.
7. Compute the dot product of vectors, lengths of vectors, and angles between vectors.
8. Perform gradient, div, curl operator on vector functions and give physical interpretations.
9. Use Green's, Gauss divergence and Stoke's theorems to solve engineering problems.

MAIR21 COMPLEX ANALYSIS AND DIFFERENTIAL EQUATIONS

<table>
<thead>
<tr>
<th>Course Code:</th>
<th>MAIR21</th>
<th>No. of Credits:</th>
<th>03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Name:</td>
<td>Complex Analysis and Differential Equations</td>
<td>Prerequisite:</td>
<td>Nil</td>
</tr>
</tbody>
</table>

COURSE LEARNING OBJECTIVES

The course presents
1. an introduction to analytic functions and power series.
2. various Cauchy’s theorems and its applications in evaluation of integral.
3. various approaches to find general solution of the ordinary differential equations.

COURSE CONTENT

Analytic functions; Cauchy-Riemann equations; Line integral, Cauchy's integral theorem and integral formula (without proof); Taylor's series and Laurent series; Residue theorem (without proof) and its applications.

Higher order linear differential equations with constant coefficients; Second order linear differential equations with variable coefficients; Method of variation of parameters; Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

Laplace Transform of Standard functions, derivatives and integrals – Inverse Laplace transform – Convolution theorem – Periodic functions – Application to ordinary differential equation.

REFERENCE BOOKS

5. Ian N. Sneddon, Elements of Partial Differential Equations, Courier Corporation, 2013

COURSE OUTCOME

Completion of the course, student will be able to
1. understand analytic functions discuss its properties
2. obtain series representation of analytic functions
3. evaluate various integrals by using Cauchy’s residue theorem
4. classify singularities and derive Laurent series expansion
5. find the solutions of first and some higher order ordinary differential equations
6. apply properties of special functions in discussion the solution of ODE.
7. Find Laplace transform of a given function and its inverse Laplace transform.

MAIR43 – Fourier transforms and Numerical techniques

<table>
<thead>
<tr>
<th>Course Code:</th>
<th>MAIR43</th>
<th>No. of Credits:</th>
<th>04</th>
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</thead>
<tbody>
<tr>
<td>Course Name:</td>
<td>Fourier transforms and Numerical techniques</td>
<td>Prerequisite:</td>
<td>MAIR11, MAIR21</td>
</tr>
</tbody>
</table>

COURSE LEARNING OBJECTIVES

Objective is to introduce
1. Fourier transform and its use to solve the mathematical equations arising in mechanical engineering.
3. Numerical Methods for Solving Linear Systems
5. Numerical Methods to solve partial differential equations
COURSE CONTENT


Solution of linear system - Gaussian elimination and Gauss-Jordan methods - LU - decomposition methods - Crout's method - Jacobi and Gauss-Seidel iterative methods - sufficient conditions for convergence - Power method to find the dominant eigenvalue and eigenvector.


Numerical solution of Laplace equation and Poisson equation by Liebmann's method - solution of one-dimensional heat flow equation - Bender - Schmidt recurrence relation - Crank - Nicolson method - Solution of one-dimensional wave equation.

REFERENCE BOOKS:


COURSE OUTCOMES:

On completion of the course, students should be able to

1. compute numerical solution of given system AX=B by direct and iterative methods.
2. compute largest eigenvalue and its corresponding eigenvector of matrix A.
3. compute numerical solution of ordinary differential equations by finite difference method.
4. compute numerical solution of partial differential equations by finite difference method.
5. Compute Fourier and inverse Fourier transform of functions.
6. Compute Fourier series of given function and interpret its coefficients.
PHIR11 PHYSICS

<table>
<thead>
<tr>
<th>Course Code:</th>
<th>PHIR11</th>
<th>No. of Credits:</th>
<th>03</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Physics</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

**COURSE LEARNING OBJECTIVES**

- To introduce the notions of light matter interaction, fabrication of lasers, light propagation in waveguides, applications of lasers and optical fibers to engineering students.
- To comprehend and explain the concepts of matter waves, wave functions and its interpretation to understand the matter at atomic scale.
- To teach the fundamentals of nuclear forces, models and classification of matter.
- To impart knowledge about the basics of conductors, superconductors, nanomaterials and their applications in science, engineering and technology.

**COURSE CONTENT**


**Fiber Optics:** Snell’s law-optical fiber – principle and construction – acceptance cone - numerical aperture –types of fibers - fiber optic communication principle – fiber optic sensors.

**Quantum Mechanics:** Inadequacy of classical mechanics-black body radiation, photoelectric effect-wave and particle duality of radiation – de Broglie concept of matter waves – electron diffraction – Heisenberg’s uncertainty principle – Schrodinger’s wave equation – eigen values and eigen functions – superposition principle – interpretation of wave function – particle confined in one dimensional infinite square well potential.

**Nuclear and Particle Physics:** Nuclear properties and forces - Nuclear models - Shell model - Nuclear reaction - Radioactivity - types and half-life. Fundamental forces - Particle physics - classification of matter - quark model.

REFERENCE BOOKS


COURSE OUTCOME

1. On completion of this course, the students will be able to,
2. know principle, construction and working of lasers and their applications in various science and engineering.
3. explain light propagation in optical fibers, types and their applications.
4. experience and appreciate the behaviour of matter at atomic scale, and to impart knowledge in solving problems in modern science and engineering.
5. understand the role of nuclear and particle physics in applications like radioactivity and nuclear reactions.
6. recognize, choose and apply knowledge to develop materials for specific applications for common needs.

PHIR12 PHYSICS LAB

<table>
<thead>
<tr>
<th>Course Code:</th>
<th>PHIR12</th>
<th>No. of Credits:</th>
<th>02</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Physics Lab</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

COURSE LEARNING OBJECTIVES

- To introduce the spirit of experiments to verify physics concepts such as reflection, refraction, diffraction and interference on light matter interaction.
- To perform experiments to estimate the materials properties and to check their suitability in science and engineering.
- To familiarize physics concepts and to design instruments and experimental set up for better and accurate measurements.
- To teach and apply knowledge to measure and verify the values of certain constants in physics.
LIST OF EXPERIMENTS

1. Determination of rigidity modulus of a metallic wire
2. Conversion of galvanometer into ammeter and voltmeter
3. Wavelength of laser using diffraction grating
4. Dispersive power of a prism – Spectrometer
5. Radius of curvature of Lens-Newton's Rings
6. Numerical aperture of an optical fiber
7. Field along the axis of a Circular coil
8. Wavelength of white light – Spectrometer
9. Calibration of Voltmeter – Potentiometer
10. Thickness of a thin wire – Air Wedge
11. Specific rotation of a liquid – Half Shade Polarimeter
12. Photoelectric effect – Planck’s constant

REFERENCE BOOKS


COURSE OUTCOME

On completion of this course, the students will be able to
1. Know how to calibrate a galvanometer and convert it into a current and voltmeters.
2. To make experimental setup to verify certain physics concepts of wave and particle nature of light.
3. Understand the light propagation in fibers, light matter interaction and use of lasers in science and engineering.
4. Acquire knowledge, estimate and suggest materials for engineering applications.

CHIR11 CHEMISTRY

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<th>Course Code:</th>
<th>CHIR11</th>
<th>No. of Credits:</th>
<th>03</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Chemistry</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

COURSE LEARNING OBJECTIVES

To introduce the student's basic principles of Electrochemistry and Corrosion. They will be familiar with phase rule & its applications. Students will know about the essential requirements of water and its importance in day-to-day life. To provide students with a brief outline of the types and applications of polymers. Finally, students will be equipped with the usage of spectroscopy in industrial applications.
COURSE CONTENT

Electrochemistry and Corrosion
Cell EMF- its measurement and applications - concentration cell - electrode electrolyte concentration cell - concentration cell with and without transference - Dry corrosion and wet corrosion, mechanisms, types of corrosion, Differential metal corrosion, differential aeration corrosion, intergranular, Passivity, Pitting, Polarization - Chemical conversion coatings and organic coatings- Paints, enamels.

Phase rule
Definition of terms – phase- components- degree of freedom- derivation of Gibbs phase rule – one component system – H₂O, CO₂, Sulfur – Two-component system – Eutectic systems – reduced phase rule - Pb-Ag system – Compound Formation with congruent melting – Zn- Mg Alloy system- Copper-nickel alloy system - systems with incongruent melting – Na₂SO₄- H₂O system and simple three-component systems.

Water
Sources, Hard & soft water, Estimation of hardness by EDTA method, Scale & Sludge- Caustic embrittlement - softening of water, zeolite process & demineralization by ion exchangers, boiler feed water, internal treatment methods-specifications for drinking water, BIS & WHO standards, treatment of water for domestic use, desalination - Reverse osmosis & Electrodialysis.

Spectroscopy

Polymers and Composites
Concept of macromolecules- Tacticity- Classification of Polymers- Types of Polymerization-Mechanism- - Ziegler Natta Polymerization - Effect of Polymer structure on properties -Important addition and condensation polymers –synthesis and properties – Molecular mass determination of polymers- Static and dynamic methods, Light scattering- Rubbers –Vulcanization – Synthetic rubbers – Conducting polymers- Composite materials

REFERENCE BOOKS

COURSE OUTCOME

- Students will learn about the Electrochemistry and phase rule.
- They will be familiarized with the importance of polymer and its application in industries.
- Additionally, a brief introduction in the area of water, spectroscopy will be very useful for the students in future endeavour.

CHIR12 CHEMISTRY LAB

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<tr>
<th>Course Code:</th>
<th>CHIR12</th>
<th>No. of Credits:</th>
<th>02</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Chemistry Lab</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

LIST OF EXPERIMENTS

1. Estimation of carbonate, non-carbonate and total hardness in the given water sample.
2. Estimation of dissolved oxygen in the given water sample.
3. Determination of the percentage of Fe in the given steel sample.
4. Estimation of Fe$^{3+}$ by spectrophotometer.
5. Corrosion rate by polarization technique
6. Conductometric titration
7. Potentiometric titration
8. pH-metric titration
9. Percentage purity of bleaching powder
10. Determination of molecular weight of the polymer by Viscometry
11. Study of three component system.
12. Demonstration experiments using Advanced Spectroscopic Techniques, (UV-Vis, FTIR, Raman)

REFERENCE BOOKS

1. Laboratory Manual, Department of Chemistry, National Institute of Technology, Tiruchirappalli.

COURSE OUTCOME

- The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.
- The students will learn how to estimate various components from the corresponding bulk mixture.
Course Code: HSIR11  No. of Credits:  04
Course Name: English for Communication  Prerequisite: Nil

COURSE LEARNING OBJECTIVES

The primary objective is to develop in the under-graduate students of engineering a level of competence in English required for independent and effective communication for academic and social needs.

COURSE CONTENT


Analytical and critical reading practice- critical, creative and lateral thinking- language and thinking – thinking process and language development.


Reciprocal relationship between reading and writing –thinking and writing - Argument Writing practice – Perspectives in writing –professional writing - Narrative writing.

Lab: Listening process & practice – Exposure to recorded & structured talks, class room lectures – Problems in comprehension & retention – Note-taking practice – Listening tests- Importance of listening in the corporate world.

Barriers to listening: Physical & psychological – Steps to overcome them – Purposive listening practice – Active listening and anticipating the speaker – Use of technology to improve the skill.


REFERENCE BOOKS


COURSE OUTCOME

The students will be able to express themselves in a meaningful manner to different levels of people in their academic and social domains.

**HSIR13 INDUSTRIAL ECONOMICS AND FOREIGN TRADE**

<table>
<thead>
<tr>
<th>Course Code:</th>
<th>HSIR13</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Industrial Economics and Foreign Trade</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

COURSE LEARNING OBJECTIVES

1. Give a simple yet thorough introduction into the main methods of economic analysis of industry structure and firm behaviour under various conditions of technology, competition, and organization.
2. Elaborate students’ skills and abilities to use modern theoretical and empirical tools to formulate and solve economic problems.
3. Explore in details how economists approach and answer specific empirical questions.

COURSE CONTENT

Demand and Supply – Forecasting techniques – Cost and Revenues.

Competitive nature of the firms – Keynesian economics – National income.


REFERENCE BOOKS:


COURSE OUTCOMES:

At the end of the course student will be able to
1. Analyze the risk of decision making in a firm.
2. Describe and explain the determinants of the size and structure of firms.
4. Explain the marketing research, product life cycle, motivation and leadership.
5. Describe the competitive nature of the firm and team working.

HSIR14 PROFESSIONAL ETHICS

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<th>HSIR14</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Professional Ethics</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

COURSE LEARNING OBJECTIVES

1. Identify the core values that shape the ethical behavior of an engineer
2. To create an awareness on professional ethics and Human Values
3. To appreciate the rights of others

COURSE CONTENT


Engineering as experimentation - engineers as responsible experimenters - Research ethics - Codes of ethics - Industrial Standard - Balanced outlook on law - the challenger case study.


Multinational corporations - Business ethics - Environmental ethics - computer ethics - Role in Technological Development - Weapons development engineers as managers - consulting engineers - engineers as expert witnesses and advisors - Honesty - leadership - sample code of conduct ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management Institution of electronics and telecommunication engineers (IETE), India, etc.,

REFERENCE BOOKS:


COURSE OUTCOME

At the end of the course student will be able to
1. Understood the core values that shape the ethical behaviour of an engineer
2. Exposed awareness on professional ethics and human values.
3. Known their role in technological development
Course Code: ENIR11
No. of Credits: 02
Course Name: Energy and Environmental Engineering
Prerequisite: Nil

COURSE LEARNING OBJECTIVES

- To teach the principal renewable energy systems.
- To explore the environmental impact of various energy sources and also the effects of different types of pollutants.

COURSE CONTENT

Present Energy resources in India and its sustainability - Different type of conventional Power Plant--Energy Demand Scenario in India-Advantage and Disadvantage of conventional Power Plants – Conventional vs Non-conventional power generation.


Power and energy from wind turbines- India’s wind energy potential- Types of wind turbines- Offshore Wind energy- Environmental benefits and impacts.

Biomass Resources-Biomass conversion Technologies- Feedstock preprocessing and treatment methods- Bioenergy program in India-Environmental benefits and impacts.


Air pollution- Sources, effects, control, air quality standards, air pollution act, air pollution measurement. Water Pollution-Sources and impacts, Soil Pollution-Sources and impacts, disposal of solid waste.


REFERENCE BOOKS

COURSE OUTCOME

Students will be introduced to the Principal renewable energy systems and explore the environmental impact of various energy sources and also the effects of different types of pollutants.

MEIR12 ENGINEERING GRAPHICS

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<th>Course Code:</th>
<th>MEIR12</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Engineering Graphics</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

COURSE LEARNING OBJECTIVES

1. Irrespective of engineering discipline, it has become mandatory to know the basics of Engineering Graphics. The student is expected to possess the efficient drafting skill depending on the operational function in order to perform day to day activity.
2. Provide neat structure of industrial drawing.
3. Enables the knowledge about position of the component and its forms Interpretation of technical graphics assemblies.
4. Preparation of machine components and related parts.

COURSE CONTENT

**Fundamentals Drawing standard** - BIS, dimensioning, lettering, type of lines, scaling-conventions.

**Orthographic projection** Introduction to orthographic projection, drawing orthographic views of objects from their isometric views - Orthographic projections of points lying in four quadrants.

Orthographic projection of lines parallel and inclined to one or both planes Orthographic projection of planes inclined to one or both planes. Projections of simple solids - axis perpendicular to HP, axis perpendicular to VP and axis inclined to one and both planes.

**Sectioning of solids** Section planes perpendicular to one plane and parallel or inclined to other plane.

**Intersection of surfaces** Intersection of cylinder & cylinder, intersection of cylinder & cone, and intersection of prisms.

**Development of surfaces** Development of prisms, pyramids and cylindrical & conical surfaces. Isometric and perspective projection Isometric projection and isometric views of different planes and simple solids, introduction to perspective projection.
REFERENCE BOOKS


COURSE OUTCOME

At the end of the course student will be able to visualize the engineering components. A number of chosen problems will be solved to illustrate the concepts clearly.

PRIR11 ENGINEERING PRACTICE

<table>
<thead>
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<th>Course Code:</th>
<th>PRIR11</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Engineering Practice</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

COURSE LEARNING OBJECTIVES

- To use hand tools and machinery in Carpentry, welding shop, Foundry, Fitting shop and Sheet Metal work.
- To manufacture engineering products or prototypes.

COURSE CONTENT

Foundry: Mould preparation for Flange and Hand Wheel, Plastic moulding / Wax moulding.

Welding: Fabrication of Butt Joint and Fabrication of Lap Joint.

Carpentry: Wood sizing exercise in planning, marking, sawing, chiseling and grooving to make; Tee Through Halving Joint and Dovetail Scarf Joint.

Fitting: Preparation of joints, markings, cutting and filling for making; Semi-circle part with the given work piece, Dovetail part with the given work piece.

Sheet metal: Fabrication of Dust Pan and Fabrication of Corner Tray.

REFERENCE BOOKS

COURSE OUTCOME

1. Know to utilize hand tools and machineries in Carpentry, Welding shop, Foundry, Fitting shop and Sheet Metal work.
2. Produce simple engineering products or prototypes

CEIR11 BASIC CIVIL ENGINEERING

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<thead>
<tr>
<th>Course Code:</th>
<th>CEIR11</th>
<th>No. of Credits:</th>
<th>02</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Basic Civil Engineering</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

COURSE LEARNING OBJECTIVES

- To give an overview of the fundamentals of the Civil Engineering fields to the students of all branches of Engineering.
- To realize the importance of the Civil Engineering Profession in fulfilling societal needs.

COURSE CONTENT

Properties and uses of construction materials - stones, bricks, cement, concrete and steel.

Site selection for buildings - Component of building - Foundation- Shallow and deep foundations - Brick and stone masonry - Plastering - Lintels, beams and columns - Roofs.


Surveying - Classification-Chain Survey-Ranging-Compass Survey-exhibition of different survey equipment.

Sources of Water - Dams- Water Supply-Quality of Water-Wastewater Treatment – Sea Water Intrusion – Recharge of Ground Water.

REFERENCE BOOKS

5. Lecture notes prepared by Department of Civil Engineering, NITT.
COURSE OUTCOME

1. The students will gain knowledge on site selection, construction materials, components of buildings, roads and water resources.
2. A basic appreciation of multidisciplinary approach when involved in Civil Related Projects.

EEIR11 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

<table>
<thead>
<tr>
<th>Course Code:</th>
<th>EEIR11</th>
<th>No. of Credits:</th>
<th>02</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Basic Electrical and Electronics Engineering</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</tbody>
</table>

COURSE LEARNING OBJECTIVES

- This course aims to equip the students with a basic understanding of Electrical circuits and machines for specific types of applications.
- The course gives a comprehensive exposure to house wiring.
- This course also equips students with an ability to understand basics of analog and digital electronics.

COURSE CONTENT

DC & AC Circuits: Current, voltage, power, Kirchhoff’s Laws - circuit elements R, L and C, phasor diagram, impedance, real and reactive power in single phase circuits.

DC & AC Machines: DC Motor, Induction motor, Synchronous motor, Synchronous generator and Transformers- construction, principle of operation, types and applications.

House wiring & safety: Single phase and three phase system – phase, neutral and earth, basic house wiring - tools and components, different types of wiring – staircase, florescent lamp and ceiling fan, basic safety measures at home and industry.

Analog Electronics: semiconductor devices – p-n junction diode, Zener diode, BJT, operational amplifier – principle of operation and applications – Introduction to UPS.

Digital Electronics: Introduction to numbers systems, basic Boolean laws, reduction of Boolean expressions and implementation with logic gates.
REFERENCE BOOKS


COURSE OUTCOME

The students shall develop an intuitive understanding of the circuit analysis, basic concepts of electrical machines, house wiring and basics of electronics and be able to apply them in practical situation.

CSIR11 INTRODUCTION TO COMPUTER PROGRAMMING

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<th>Course Code:</th>
<th>CSIR11</th>
<th>No. of Credits:</th>
<th>03</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Introduction to Computer Programming</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To learn the fundamentals of computers.
2. To learn the problem solving techniques using algorithms and procedures
3. To read, write and execute simple Python Programs
4. To learn and use Python data structures – lists, tuples and dictionaries

COURSE CONTENT


Data types; variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments; understanding error messages; Conditions, Boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation

Strings and text files; manipulating files and directories, OS and SYS modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab-separated). String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa. Binary, octal, hexadecimal numbers
Lists, tuples, and dictionaries; basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values; traversing dictionaries.

Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments- Program structure and design- Recursive functions – Introduction to classes and OOP.

**List of Programs**

1. Programs using sequential constructs
2. Programs using selection constructs
3. Programs using Iterative constructs
4. Programs using nested for loops
5. Programs using lists
6. Programs using tuples and dictionaries
7. Simple Python functions
8. File input and output
9. Sorting and searching programs
10. Recursion

**REFERENCE BOOKS**


**COURSE OUTCOME**

1. Write algorithms for problems
2. Use syntax and semantics of Python programming language for problem solving
3. Code a given logic in Python language
4. Appreciate and apply appropriate Data structures available in Python language for solving problems
MEIR15 – INTRODUCTION TO MECHANICAL ENGINEERING

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<th>Course Code:</th>
<th>MEIR15</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Introduction to Mechanical Engineering</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To introduce and define the basics concept of mechanical engineering.
2. To familiarize the working principles of IC engines and automobile systems.
3. To enable the students to understand the details about the energy systems and its components.
4. To demonstrate the various machine elements, materials and its function.
5. To help the students acquire knowledge about the various manufacturing process.

COURSE CONTENT

Introduction to Mechanical Engineering, Thermal Engineering, Design, manufacturing Engineering. Role and Responsibilities of a Mechanical Engineers


Energy Systems - Power plants, Types, Gas Turbines, Steam Turbines, Utility boilers, R & A/C system- Green Energy production and Devices – Fluid Movers, Pumps and Compressors

Engineering materials, Machine elements and its functions

Manufacturing, Classification, Metal forming, Casting, Lathe, drilling machines, Milling machines, Metal joining, Additive Manufacturing.

REFERENCE BOOKS:

1. Lecture notes prepared by Department of Mechanical Engineering, NITT.

COURSE OUTCOMES

At the end of the course, students will be able

1. To identify the basic concept and fundamentals of mechanical engineering.
2. To understand the working principle of IC engines and Energy systems.
3. To appreciate the process and materials involved in the manufacture of various machine element components.
MEIR16 – SUMMER INTERNSHIP

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<tbody>
<tr>
<td>Course Name:</td>
<td>Summer Internship</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To provide undergraduate engineering students with hands-on exposure to industry facilities, thereby furthering their understanding of the basics and operations of sciences and its applications.
2. During the assignment period, students apart from technical exposure, will also learn to work in teams that possess diverse knowledge and skills; experience project management; develop time management; and most importantly learn to understand rules and regulations as well as adhere to policies and procedures.
3. Students’ communication and presentation skills are expected to improve after the internship period as a result of constant contacts with mentors and administrative personnel.
4. Students must make the best use of this opportunity to apply their theoretical background in engineering learned at the PI to solve design and maintenance problems and demonstrate an awareness of current and future engineering applications in the industry.

COURSE OUTCOME

At the end of the course, students will be

1. An ability to function on multi-disciplinary teams.
2. An ability to identify, formulate and solve engineering problems.
3. An understanding of professional and ethical responsibility.
4. An ability to communicate effectively with written, oral and visual means.
5. The broad education necessary to understand the impact of engineering solution in a global and society context.
6. A recognition of the need for and ability to engage in life-long learning.

MEIR17 – PROJECT WORK

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<tbody>
<tr>
<td>Course Name:</td>
<td>Project Work</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
2. To train the students in preparing project reports and to face reviews and viva voce examination.
At the end of the course student will
1. Identify real world problems of mechanical engineering and related systems.
2. Interpret the working of mechanical engineering systems.
3. Apply the principles of mechanical engineering in real world systems.
4. Criticize and experiment to arrive at solutions for real world mechanical engineering problems.
5. Analyse and evaluate to obtain solution for problems in mechanical engineering systems.

MEIR18 – COMPREHENSIVE VIVA

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<tr>
<th>Course Code:</th>
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<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Comprehensive Viva</td>
<td>Prerequisite:</td>
<td>Nil</td>
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COURSE LEARNING OBJECTIVES

1. The objective of the comprehension exam is to attain an understanding of the concepts of simultaneous manufacturing systems including materials, fabrication process, product and process control, manufacturing with computer and quality management.
2. The students work in groups and solve different types of problems/ activities given to them.
3. The activities given to the students should be real time like problems in industries chosen by a team of faculty members of the concerned department.
4. A minimum of three small problems have to be solved by each group of students
5. The evaluation is based on continuous assessment by group of faculty members constituted by the professor in-charge of the course.

COURSE OUTCOMES

Recall, recognize, visualize, illustrate, demonstrate, criticize and appraise the aspects of mechanical engineering systems and the interaction among them.

MEIR19 – INDUSTRIAL LECTURE

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<tbody>
<tr>
<td>Course Name:</td>
<td>Industrial Lecture</td>
<td>Prerequisite:</td>
<td>Nil</td>
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COURSE LEARNING OBJECTIVES

1. To provide hands-on training to truly appreciate the various fields of mechanical engineering related concepts.
2. Invited talks from industry experts are planned to further enrich the course.
COURSE OUTCOME

At the end of the course, student skills, personal, exposure and knowledge will be developed.

SWIR11 – NSS/ NCC/ NSO

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<th>SWIR11</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>NSS/ NCC/ NSO</td>
<td>Prerequisite:</td>
<td>Nil</td>
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COURSE LEARNING OBJECTIVES

To enable the students to gain knowledge about NCC/NSS/NSO/YOGA and put the same into practice

COURSE CONTENT

**National Cadet Corps (NCC)** – Any student enrolling as a member of National Cadet Core (NCC) will have to attend sixteen parades out of twenty parades each of four periods over a span of academic year. Attending eight parades in first semester will qualify a student to earn the credits specified in the curriculum. Grading shall be done based on punctuality, regularity in attending the parades and the extent of active involvement.

**National Service Scheme (NSS)** – A student enrolling as member of NSS will have to complete 60 hours of training / social service to be eligible to earn the credits specified in the curriculum. Grading shall be done by the faculty member handling the course based on punctuality, regularity in attending the classes and the extent of active involvement.

**National Sports Organization (NSO)** – Each student must select one of the following games/sports events and practice for one hour per week. An attendance of 75% is compulsory to earn the credits specified in the curriculum. Grading shall be done by the faculty member handling the course based on punctuality, regularity in attending the classes and the extent of active involvement. List of games/sports: Basket Ball, Football, Volleyball, Ball Badminton, Cricket, Throw-ball, Track events Field events or any other game with the approval of faculty member.

COURSE OUTCOME

To imbibe in the minds of students the concepts and benefits of NCC/NSS/NSO/YOGA and make them practice the same
II. PROGRAMME CORE (PC)

MEPC10 – ENGINEERING MECHANICS

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<th>Course Code:</th>
<th>MEPC10</th>
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<tr>
<td>Course Name:</td>
<td>Engineering Mechanics</td>
<td>Prerequisite:</td>
<td>Nil</td>
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COURSE LEARNING OBJECTIVES

1. To explain the importance of mechanics in the context of engineering and conservation principles
2. To explain the significance of centroid, center of gravity, and moment of inertia.
3. To introduce the techniques for analyzing the forces in the bodies.
4. To analyze the internal member forces acting on structures.
5. To understand the basic principles involved in the dynamics of particle and rigid body.

COURSE CONTENT

Fundamentals: Mechanics and its relevance, concepts of forces, laws of mechanics – Lami’s Theorem, Concept of free-body diagram, centroids, center of gravity, area moment of inertia, mass, moment of inertia.

Statics: Principles of statics, Types of forces, concurrent and non-concurrent forces, composition of forces, forces in a plane and space, simple stresses and strains, elastic constant.

Friction: Laws of friction, application of laws of friction, wedge friction, body on inclined planes.

Dynamics: Principles of dynamics, D’Alembert’s principle, conservation of momentum and energy.

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will

1. To be able to draw free body diagram and identify unknown reactions at supports
2. To be able to locate the center of gravity and mass center of an object and compute the mass and area moment of inertia.
3. Effective utilization of the gravitational and frictional forces in mechanical systems
4. To be able to compute the linear and angular acceleration of translating and rotating bodies
5. Ability to compute the energy required to establish prescribed motion of rigid body

MEPC11 – ENGINEERING THERMODYNAMICS

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<tbody>
<tr>
<td>Course Name:</td>
<td>Engineering Thermodynamics</td>
<td>Prerequisite:</td>
<td>Nil</td>
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COURSE LEARNING OBJECTIVES

1. To learn the principles of work and energy.
2. To acquire knowledge about the fundamentals of thermodynamic laws, concepts and principles.
3. To understand the principles of various cycles and to apply the thermodynamic concepts in various applications like IC engines and Air conditioning systems

COURSE CONTENT

Basic definitions - microscopic and macroscopic approaches, engineering thermodynamic systems. Thermodynamic properties - definition and units, intensive, extensive properties, specific properties. Thermodynamic state - state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic processes. Thermodynamic equilibrium; definition, mechanical equilibrium, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics and the concept of temperature. Measurement of temperature. Thermodynamic definition of work and heat, sign convention. Displacement work - expressions through p-v diagrams. Shaft work; Electrical work. Other types of work.


REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will

1. Define the fundamentals of the first and second laws of thermodynamics and explain their application to a wide range of systems.
2. Analyze the work and heat interactions associated with a prescribed process path and to perform analysis of a flow system.
3. Evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.
4. Analyze various thermodynamic cycles

MEPC12 – STRENGTH OF MATERIALS

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<th>Course Code:</th>
<th>MEPC12</th>
<th>No. of Credits:</th>
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<tr>
<td>Course Name:</td>
<td>Strength of Materials</td>
<td>Prerequisite:</td>
<td>Nil</td>
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COURSE LEARNING OBJECTIVES

1. To develop the theoretical basis about the stress, strain and elastic modulus concepts in various components.
2. To understand the mechanical behavior of materials.
3. To familiarize the student in calculating shear force, bending moment, deflection and slopes in various types of beams for different loading conditions
4. To solve practical problems related to springs and shafts.
COURSE CONTENT


Thin cylindrical and spherical shells subjected to internal pressure. Principal stresses and their planes. Plane of maximum shear – Mohr’s circle of stresses. Thick cylinders – Lame’s equation, shrink fit. Compound cylinders.

Shear force and bending moment diagrams for beams subjected to different types of loads – Theory of simple bending and assumptions.

Leaf spring, shear stress. Deflection – The moment area method, Macaulay’s method – superposition (statically determinate beams only).

Torsion of solid and hollow circular shafts – Power transmission, strength and stiffness of shafts. Stress and deflection in open helical spring.

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will

1. Analyze and design structural member subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.
2. Ability to draw the mohr’s circle and to determine the principle stresses and its directions.
3. Calculate the stresses and strain associated with thin wall spherical & cylindrical pressure vessels
4. Present the concept of shear force, bending moment, slope and deflection and their use in machine design.
5. Understand the structural stability long columns under different supporting conditions.

**MEPC13 – APPLIED ELECTRICAL AND ELECTRONICS ENGINEERING**

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<tbody>
<tr>
<td>Course Name:</td>
<td>Applied Electrical and Electronics Engineering</td>
<td>Prerequisite:</td>
<td>EEIR11</td>
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**COURSE LEARNING OBJECTIVES**

1. To provide the key concepts about AC motors and thereby able to choose the appropriate drives for various applications.
2. To equip students to understand and apply the basic concepts of control techniques used for drives in industries and to appraise the implementation of various control circuits

**COURSE CONTENT**


Single phase induction motors and universal motors- applications. Synchronous motors – principle of operation, starting and applications.

Electric drive for general factory, textile mill, cement mill - pump, blowers, hoists, traction etc. - group and individual drives. Choice of motors for various applications – drive characteristics and control of drives.

Introduction to operational amplifiers – applications in control circuits. Combinational logic - representation of logic functions – SOP and POS forms K-map representations – minimization using K maps - simplification and implementation of combinational logic – multiplexers and demultiplexers – Introduction to micro-processors and micro-controllers

Control systems – introduction – block diagram reduction – Routh Herwitz criterion based stability analysis – implementation of control logics to drives.

**List of experiments**

1. Speed control of three phase induction motor
2. Load test on three phase induction motor
3. Load test on single phase induction motor
4. Realization of integrator and differentiator using operational amplifiers
5. Simulation of performance of three phase induction motor using control blocks
REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will be able to

1. Analyze the performance of AC motors under various operating conditions using their various characteristics.
2. Choose appropriate motor for various applications in industries
3. Design and analyze combinational logic circuits.
4. Understand the architecture and instruction set of 8085.
5. Analyse the various control logics for industrial drive applications

MEPC14 – FLUID MECHANICS AND MACHINES

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<th>MEPC14</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Fluid Mechanics and Machines</td>
<td>Prerequisite:</td>
<td>Nil</td>
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COURSE LEARNING OBJECTIVES

1. To familiarize with the properties of fluids and the applications of fluid mechanic and fluid machines.
2. To formulate and analyze problems related to calculation of forces in fluid structure interaction.
3. To classify flows and to understand and apply the conservation principles for fluid flows.
4. To understand the principles of dimensional analysis.
5. To analyze design aspects of the fluid machinery and introduce the methods to study their flow behavior.

COURSE CONTENT

Introduction: Fluids and continuum, Physical properties of fluids, Newton’s law of viscosity. Ideal and real fluids, Newtonian and non - Newtonian fluids. Fluid Statics-Pressure -density-height relationship,
manometers, pressure on plane and curved surfaces, center of pressure buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform accelerations, measurement of pressure.

**Kinematics of fluid flow:** Eulerian and Lagrangian approaches, classification of fluid flow, 1-D, 2-D and 3-D flow, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational flows, stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid, circulation and vorticity, stream function and potential function.

**Inviscid flow:** Euler equation, Bernoulli’s equation and its applications, Reynolds transport theorem: conservation of mass, linear and angular momentum, Navier-Stokes equations (without proof): some exact solutions Pipe Flow: Viscous flow: Reynolds experiment to classify laminar and turbulent flows, significance of Reynolds number, critical Reynolds number, shear stress and velocity distribution in a pipe, law of fluid friction, head loss due to friction, Hagen-Poiseuille Equation. Turbulent flow: Darcy-Weisbach equation, Chezy’s equation Moody’s chart, Major and minor energy losses.

**Concept of Boundary Layer:** Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer, velocity profile, calculation of drag, boundary layer separation. Dimensional analysis and similarity: Buckingham Pi theorem, Model Testing and Dimensionless numbers.

**Fluid Machinery:** similarity, Euler equation for turbomachines, velocity triangles, centrifugal and axial flow pumps, hydraulic turbines – impulse and reaction, cavitation, water hammer, introduction to air compressors, fans and blowers.

**REFERENCE BOOKS:**


**COURSE OUTCOMES**

At the end of the course student will be able to

1. Calculate pressure variations in accelerating fluids using Euler’s and Bernoulli’s equations
2. Become conversant with the concepts of flow measurements and flow through pipes 3. Apply the momentum and energy equations to fluid flow problems.
3. Evaluate head loss in pipes and conduits.
4. Use dimensional analysis to design physical or numerical experiments and to apply dynamic
similarity

MEPC15 – MECHANICS OF MACHINES – I

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<th>Course Code:</th>
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<td>No. of Credits:</td>
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<tr>
<td>Course Name:</td>
<td>Mechanics of Machines – I</td>
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<td>Prerequisite:</td>
<td>MEPC10</td>
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COURSE LEARNING OBJECTIVES

1. To impart knowledge on various types of Mechanisms and its generalization
2. To understand kinematic diagram of mechanism and perform synthesis
3. To impart skills to do position analysis
4. To impart skills to analyze velocity and acceleration of linkages in mechanisms
5. To familiarize higher pairs like cams and gears

COURSE CONTENT

Kinematics Fundamentals: Types of links, Degrees of freedom - Kinematic chains, mechanisms, Machines - lower pairs and higher pairs - Mobility-Number Synthesis – isomers -Linkage Transformation – inversions - Grashof conditions - Barker’s classification - Rotatability and revolvability of N bar Linkages - Compliant Mechanism-MEMS

Graphical Linkage Synthesis: Two position synthesis, rocker output coupler output - three position synthesis - quick return mechanism - coupler curves-symmetrical 4-bar linkage –cognates - introduction to synthesis using coupler curve atlas-limiting conditions, toggle position and transmission angle. Introduction to animation software: Working model

Position analysis: translation rotation and complex motion - Euler's theorem and Chasles’ theorem - graphical position analysis - algebraic position analysis - vector loop equation for four bar linkages - circuits and branches in linkages

Velocity analysis: definition of velocity - graphical velocity analysis - instant centers of velocity - Kennedy’s rule - velocity analysis using instant centers - mechanical advantage-centrodes - analytical velocity analysis of a 4 bar linkage

Acceleration analysis: definition of acceleration-graphical acceleration analysis - analytical acceleration Analysis - Coriolis acceleration-human tolerance to acceleration

Cams: types of cams and followers-types of motion program-pressure angle and radius of curvature
Gears: fundamental law of gearing - involute tooth form-pressure angle – changing center distance-interference and under cutting- contact ratio - types of gears-simple gear trains - compound gear trains - epicyclic gear Trains - Ferguson’s paradox

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will be able
1. To perceive the importance of motion transformation involved in various mechanisms and able to make classifications
2. Gain the knowledge of synthesis methods and use software for mechanism animation
3. To precisely perform position analysis of linkages in mechanisms
4. To quantify the velocity and acceleration at required regions in a mechanism
5. Able to analyze the cams and gears and initiate design steps

MEPC16 – MANUFACTURING TECHNOLOGY

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<tr>
<td>Course Name:</td>
<td>Manufacturing Technology</td>
<td>Prerequisite:</td>
<td>Nil</td>
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COURSE LEARNING OBJECTIVES

1. To learn the various methods and types of castings, welding processes, sheet metal forming, plastics.
2. To impart knowledge on selection of suitable manufacturing process for the typical component.
3. To understand the working of machine tools such as lathe, shaper, planner, slotter, milling, hobbing, and grinding.
4. To know the basic concepts of NC and CNC machine tool programming and additive manufacturing processes

**COURSE CONTENT**


NC & CNC machine tools and manual part programming Machining centre. NC part programming – Computer aided part programming - Rapid Prototyping processes: Stereolithography, Fused Deposition modelling, 3D Printing, Selective laser sintering – Rapid Tooling techniques

**REFERENCE BOOKS:**

10. Ian Gibson, David W.Rosen, Brent Stucker, Additive manufacturing technologies; rapid prototyping to direct digital manufacturing, Springer,2010
COURSE OUTCOMES

At the end of the course student will be able to
1. Recognize the different types of casting and welding process.
2. Explain the concept of forging, rolling process and drawing.
3. Explain the features and applications of various machining processes.
4. Recognize the knowledge of NC & CNC Part programming and Additive Manufacturing process

MEPC17 – THERMAL ENGINEERING

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<tr>
<td>Course Name:</td>
<td>Thermal Engineering</td>
<td>Prerequisite:</td>
<td>MEPC11</td>
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COURSE LEARNING OBJECTIVES:

1. To enable the students, understand the principles, working and performance of IC engines
2. To introduce students to the working of compressors, steam nozzles and various refrigeration and air-conditioning systems.
3. To teach students the principles of waste heat recovery and thermal storage systems.

COURSE CONTENT

Classification of IC engines – Working of SI & CI, two and four stroke engines – Ideal and actual valve and port timing diagrams – Comparison of ideal and actual air standard cycles (p-v diagram) – Engine operating characteristics: mean effective pressure, torque and power, specific fuel consumption, efficiencies, pressure-crank angle diagram – Determination of fuel properties – Thermochemistry of fuels – Calculation of air fuel ratio – stochiometric, lean and rich mixtures – Exhaust gas analysis

Subcritical and supercritical boilers, fluidized bed boilers, fire-tube and water-tube boilers, mountings and accessories - Steam turbine basic cycles – velocity diagrams, Work done and efficiency – Multistage turbines, governing systems, Effects of reheating and regeneration, Application of Mollier diagram, Gas turbine basic cycle (open and closed), Application of intercooling, reheating and regeneration – cogeneration and combined system


REFERENCE BOOKS:


COURSE OUTCOME:

Student will be able to
1. Solve problems on internal combustion engines and prepare heat balance sheet.
2. Get an insight of various components and principles of engines, boilers, compressors, Steam Nozzles, etc.
3. Design refrigeration and air-conditioning system for a particular application.
4. Demonstrate the knowledge of waste heat recovery and thermal storage.

MEPC18 – ENGINEERING MATERIALS

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<tr>
<td>Course Name:</td>
<td>Engineering Materials</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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COURSE LEARNING OBJECTIVES

1. To impart knowledge on the atomic arrangement and structure of metals and alloys.
2. To acquire sound knowledge on phase diagram and heat treatment of materials.
3. To understand the influence of material processing on the material properties
4. To deepen the knowledge about stress-strain curves and metal plasticity
5. To understand the various material testing methods.
COURSE CONTENT

**Materials Fundamentals:** material classification, atomic structure, atomic bonding in solids, crystal structure, crystal systems, crystallographic directions, Miller-Bravais scheme, crystallographic planes, Polycrystalline Materials. Imperfections: point defects, dislocations, Burger vector, grain size, microscopic techniques.


**Material Processing:** Ferrous Alloys - classifications, Nonferrous Alloys - copper and aluminum alloys, forming, casting, Heat treatments: Annealing, Precipitation hardening, austempering, martempering, ausforming, surface hardening, hardenability.

**Testing:** Concepts of stress-strain, elastic properties, tensile properties, true stress-strain, elastic recovery and plastic deformation, hardness. Dislocations and Strengthening Mechanisms: Characteristics of dislocation, slip systems and slip in single crystal. Plastic deformation in polycrystalline materials, twinning, strengthening by grain size reduction, strain hardening, recovery, recrystallization, grain growth.

**Failure:** Fracture - Fundamentals of Fracture, Ductile and brittle fracture, Impact Fracture Testing. Fatigue – Cyclic stress, S-N curve, crack initiation and propagation, fatigue life and improvement methods, Creep behavior, stress and temperature effects, alloys for high temperature.

**Laboratory Experiments:**

Metallography specimen preparation, Optical microscopy (micro structure evaluation of cast iron, carbon steel. stainless steel and alloy steels), Mechanical Characterization of materials- Tensile testing, Impact testing and Hardness testing, heat treatment of steels – annealing, normalizing, and quenching microstructure comparison.

**REFERENCE BOOKS:**

COURSE OUTCOMES

At the end of the course student will
1. Interpret the atomic arrangement and structure of metals and alloys.
2. Describe the iron-carbon equilibrium diagram and phase diagrams.
3. Explain the behavior of material upon heat treatment from iron-carbon equilibrium diagram
4. Interpret the uniaxial tension test and ductility of various materials
5. Predict the behavior of materials upon impact, fracture and creep testing

MEPC19 – HEAT AND MASS TRANSFER

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<tr>
<td>Course Name:</td>
<td>Heat and Mass Transfer</td>
<td>Prerequisite:</td>
<td>MEPC11</td>
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COURSE LEARNING OBJECTIVES

1. To learn the various modes of heat transfer and understand the basic concepts of mass transfer.
2. To understand the applications of various experimental heat transfer correlations in engineering applications.
3. To discuss the thermal analysis and sizing of heat exchangers.

COURSE CONTENT


Heat exchangers - types - fouling factor - LMTD and NTU methods - Mass transfer - Fick's law - analogy between heat and mass transfer

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course, students will be able to
1. Analyze the real time applications of conduction heat transfer in solids.
2. Describe the fundamentals of natural and forced convective heat transfer processes.
3. Design the heat exchange equipment.
4. Explore the real time applications of radiation mode of heat transfer.
5. Relate the mass transfer concepts for various industrial applications.

MEPC20 – MECHANICS OF MACHINES – II

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<tbody>
<tr>
<td>Course Name:</td>
<td>Mechanics of Machines – II</td>
<td>Prerequisite:</td>
<td>MEPC15</td>
</tr>
</tbody>
</table>

COURSE LEARNING OBJECTIVES

1. To establish strong foundation in kinetics of mechanisms
2. To familiarize balancing methods for rotating and reciprocating masses
3. To introduce gyroscope and flywheels
4. To familiarize fundamentals of vibrations in machineries
5. To understand vibration control

COURSE CONTENT

Fundamentals of dynamics: center of mass, mass moment of inertia, principle of virtual work. Static and inertial force analysis of mechanisms: Newtonian method, four-bar linkage, slider crank, shaking force and moment.
Balancing: rotating masses in single and several planes- reciprocating masses- single and multi-cylinder engines-Lanchester balancer


Mechanical vibrations: Introduction to vibration, Types of vibration, single DoF system, Free vibration of rigid bodies, linear and torsional vibrations- two rotor, three rotors and multi rotor systems- damped vibrations, types of damping - coupled vibrations - forced vibrations - vibration sensors

Vibration control: philosophy of vibration control-vibration isolations- suspension systems-tuned vibration absorbers- uses of vibration in condition monitoring

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will

1. Perform static and dynamic analysis of mechanisms
2. Understand the issues related to balancing of reciprocating and rotating machinery
3. Know the working of gyroscopes and flywheels
4. Have understanding about the types and effects of vibration
MEPC21 – METROLOGY AND MEASUREMENTS

Course Code: MEPC21  
Course Name: Metrology and Measurements  
No. of Credits: 03  
Prerequisite: NIL

COURSE LEARNING OBJECTIVES

1. Describe the evolution of quality standards and metrology.
2. Provide knowledge of limits, fits, tolerances and gauging.
3. Introduce measurement systems and methods with emphasis on different transducers, intermediate modifying and terminating devices.

COURSE CONTENT

Introduction to Metrology- Introduction to Metrology, Fundamental principles and definitions, measurement standards / primary and tertiary standards, distinction between precision and accuracy. Limits, fits and tolerances, Tolerance grades, Types of fits, IS919, GO and NO GO gauges- Taylor's principle, design of GO and NO GO gauges, filler gauges, plug gauges and snap gauges.

Comparators - Constructional features and operation of mechanical, optical, electrical/electronic and pneumatic comparators, advantages, limitations and field of applications. Principles of interference, concept of flatness, flatness testing, optical flats, optical interferometer and laser interferometer. Surface Texture Measurement - importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters- Ra, Ry, Rz, RMS value etc., surface roughness measuring instruments – Tomlinson and Taylor Hobson versions, surface roughness symbols.

Screw Thread Measurement - Two wire and three wire methods, floating carriage micrometer. Gear Measurement - Gear tooth comparator, Master gears, measurement using rollers and Parkinson’s Tester. Special Measuring Equipment - Principles of measurement using Tool Maker’s microscope profile projector & 3D coordinate measuring machine


Principles and analysis of measurement systems used for measurement of flow, power, pressure and temperature.

REFERENCE BOOKS:

COURSE OUTCOMES

At the end of the course student will
1. Demonstrate different measurement techniques.
2. Reproduce the fundamental knowledge on metrology techniques.
3. Identify suitable metrological methods for measuring the components.
4. Explain the acceptance test for machines.
5. Outline the working of various optical measuring instruments.

MEPC22 – AUTOMOBILE ENGINEERING

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<tr>
<th>Course Code:</th>
<th>MEPC22</th>
<th>No. of Credits:</th>
<th>03</th>
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</thead>
<tbody>
<tr>
<td>Course Name:</td>
<td>Automobile Engineering</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To study the automobile structure, comfort and safety systems.
2. To impart knowledge on IC engine, electric and hybrid vehicles.
3. To understand the manual and automatic transmission systems.
4. To understand vehicle running and control systems.
5. To analyze various electrical and electronics system for vehicle management.

COURSE CONTENT

Vehicle Structure, Comfort and Safety

Engine and Auxiliary Systems
Transmission Systems

Steering, Brakes and Suspension Systems

Automotive Electrical and Electronics


REFERENCE BOOKS:

COURSE OUTCOMES

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

1. Understand the automobile structure, comfort and safety systems.
2. Understand the principles of IC engine, electric and hybrid vehicles.
3. Understand the manual and automatic transmission systems.
4. Understand vehicle running and control systems.
5. Analyse various electrical and electronics system for vehicle management.

MEPC23 – ENERGY CONVERSION SYSTEMS

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<th>MEPC23</th>
<th>No. of Credits:</th>
<th>03</th>
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<tr>
<td>Course Name:</td>
<td>Energy Conversion Systems</td>
<td>Prerequisite:</td>
<td>MEPC17</td>
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</tbody>
</table>

COURSE LEARNING OBJECTIVES:

1. Analyze the thermodynamic cycles used in power generation
2. Evaluate the merits of direct thermal energy conversion systems compared to conventional techniques
3. Analyze the performance of fuel cells
4. Select the best energy storage mechanism for any given application
5. Developing a mechanism for total energy recovery from a system adopting CHCP concept

COURSE CONTENT

Energy Conversion Cycles: Bell Coleman, Scuderi, Stirling, Ericsson, Lenoir, Atkinson, Stoddard and Kalina cycle – Comparison with Rankine and Brayton cycles


REFERENCE BOOKS:


COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Analyze the thermodynamic cycles used in power generation
2. Evaluate the merits of direct thermal energy conversion systems compared to conventional techniques
3. Analyze the performance of fuel cells
4. Select the best energy storage mechanism for any given application
5. Develop a mechanism for total energy recovery from a system adopting CHCP concept

MEPC24 – DESIGN OF MACHINE ELEMENTS

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<tr>
<td>Course Name:</td>
<td>Design of Machine Elements</td>
<td>Prerequisite:</td>
<td>MEPC12, MEPC15</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To familiarize machine components failure under various loadings
2. To develop the basic steps involved in the design of shaft and couplings.
3. To analyze the functional and strength requirements of various mechanical joints and bearings.
4. To understand the factors involved in the design of springs, flexible elements and gears.

COURSE CONTENT

Failure Theories – failure theories of ductile and brittle materials under static loading, Fatigue failure theories: Mechanism, Models, Notches and stress concentration.


Design of Welding and Fastening: Joints subjected to axial and eccentric loads.

Design of Flexible mechanical elements – Belt, Chain and Rope.

Design of Gears – Gear Terminologies, Types of gears, Materials for gears, Design of Spur Gear, Helical Gear, Bevel gears, Worm and Worm Gear

Design of single stage and multistage Gear boxes.

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will
1. Describe the design process, material selection, stress concentrations under various loading.
2. Ability to design the machine elements like shaft, couplings, bearings and springs.
3. Recognize the need and procedure to design flexible and positive drives.
4. Apply catalogues and standards in machine component design.
III. ESSENTIAL LABORATORY REQUIREMENT COURSES

MELR11 – STRENGTH OF MATERIALS AND FLUID MECHANICS & MACHINES LABORATORY

<table>
<thead>
<tr>
<th>Course Code:</th>
<th>MELR11</th>
<th>No. of Credits:</th>
<th>02</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Strength of Materials and Fluid Mechanics &amp; Machines Laboratory</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
</tr>
</tbody>
</table>

COURSE LEARNING OBJECTIVES

1. To study the mechanical properties of materials when subjected to different types of loading.
2. To verify the principles studied in Fluid Mechanics theory by performing experiments in lab.

COURSE CONTENT

Strength of Materials - List of Experiments
1. Tension test on mild steel rod
2. Torsion test on mild steel rod
3. Hardness test on metal beam (Rockwell and Brinell Hardness Tests)
4. Compression test on helical spring
5. Deflection test on carriage spring

Fluid Mechanics - List of Experiments
1. Flow through Venturi meter
2. Characteristics of Centrifugal pumps
3. Characteristics of Gear pump
4. Characteristics of Submersible pump
5. Characteristics of Reciprocating pump
6. Characteristics of Francis turbine
7. Determination of Metacentric height

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:
1. Perform Tension, Torsion, Hardness, Compression, and Deformation test on Solid materials.
2. Use the measurement equipment’s for flow measurement.
3. Perform test on different fluid machinery.
MELR12 – COMPUTER AIDED MACHINE DRAWING

<table>
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<th>Course Code:</th>
<th>MELR12</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Computer Aided Machine Drawing</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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</tbody>
</table>

COURSE LEARNING OBJECTIVES

1. Applying standard drawing practices using fits and tolerances.
3. Preparing standard drawing layout for modeled parts or assemblies with BoM.
4. Exposing the student to contemporary computer design tools for aerospace and mechanical engineers.

COURSE CONTENT:


Drawing, Dimensioning, Detailing of various components -

Shaft Couplings: rigid, flexible: cotter joints, knuckle joints, Hook’s joints. Bearings - Journal - Footstep, thrust or Collar bearing; Plummer block; Pulleys for flat belts, V-belt and rope.


Reference Books:


COURSE OUTCOMES

At the end of the course student will

1. Identify the national and international standards pertaining to machine drawing.
2. Apply limits and tolerances to assemblies and choose appropriate fits.
3. Recognize machining and surface finish symbols.
4. Explain the functional and manufacturing datum.
5. Illustrate various machine components through drawings.
COURSE LEARNING OBJECTIVES

1. To provide knowledge on testing of properties of fuels and lubricating oils
2. To demonstrate and conduct experiments, interpret and analyze data and report the results of IC Engine testing.

COURSE CONTENT

1. Valve timing and port timing diagrams.
2. Heat balance test on 4-stroke water cooled and Air cooled Engine.
3. Morse test on Multi-cylinder four stroke SI Engine.
4. Performance test on Multi-cylinder four stroke Engine.
5. Performance test on single cylinder two stroke Engine
6. Performance and combustion studies on computerized IC engine test rig.
7. Study and performance test on a reciprocating Air Compressor
8. Determination of viscosity using Redwood viscometer.
9. Flash point and Fire point test using Cleveland apparatus.
10. Flash point and Fire point test using Pensky Martens apparatus.
11. Determination of calorific value for liquid and gaseous fuels.
13. Determination of derived cetane number of fuel using cetane analyzer
14. Determination of moisture content in fuel using Karl Fischer Coulometry
15. Study the elemental composition of fuel using ultimate analyzer
16. Categorize the organic compounds of fuel using proximate analysis.

COURSE OUTCOMES

At the end of the course student will be able to:
1. Determine the property of fuels and lubricating oils.
2. Evaluate the performance of internal combustion engines and air compressors.
3. Interpret the emission characteristics of internal combustion engines.
Department of Mechanical Engineering, National Institute of Technology, Tiruchirappalli

MELR14 – MANUFACTURING TECHNOLOGY LABORATORY

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<th>Course Code:</th>
<th>MELR14</th>
<th>No. of Credits:</th>
<th>02</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Manufacturing Technology Laboratory</td>
<td>Prerequisite:</td>
<td>NIL</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc. and to equip with the practical knowledge required in the core industries.
2. To Study and acquire knowledge on various basic machining operations in special purpose machines and its applications in real life manufacture of components in the industry.

COURSE CONTENT

1. Lathe – Simple / Step / Taper Turning, Thread Cutting, Drilling and Boring.
2. Shaping – V – Cutting
4. Hobbing – Spur Gear Cutting
5. Grinding – Surface / Cylindrical grinding
6. CNC Lathe – Simple Turing, Step Turning, Thread Turing
7. Machining Center – A typical job production.
9. Additive manufacturing/3D printing

COURSE OUTCOMES

Upon completion of this course, the students can able
1. To demonstrate and fabricate different types of components using the machine tools.
2. To use different machine tools to manufacturing gears.
3. To use different machine tools for finishing operations.
4. To manufacture tools using cutter grinder.
5. To develop CNC part programming.
MELR15 – HEAT TRANSFER AND REFRIGERATION & AIR-CONDITIONING LABORATORY

<table>
<thead>
<tr>
<th>Course Code:</th>
<th>MELR15</th>
<th>No. of Credits:</th>
<th>02</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Heat Transfer and Refrigeration &amp; Air-Conditioning Laboratory</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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</tbody>
</table>

COURSE LEARNING OBJECTIVES

1. To expose the students to the basic knowledge of thermal equipment’s and help them to develop experimental skills.
2. To study the concepts, applications of the thermal engineering laboratory.

COURSE CONTENT

1. Study and performance tests on vapour compression refrigeration.
2. Study and performance tests on vapour absorption refrigeration.
3. Study and performance tests on air conditioning test rig.
4. Heat transfer experiments based on conduction and convection.
5. Heat transfer experiments based on radiation.

COURSE OUTCOMES

At the end of the course student will
1. Demonstrate conduction, convection and radiation heat transfer through experiments.
2. Interpret heat transfer enhancement mechanisms.
3. Estimate the size and type of heat exchangers.
4. Calculate the cooling load of air conditioning systems and cooling towers.
COURSE LEARNING OBJECTIVES

1. Identify the uncertainties in dimensional metrology and the define the measurement standards; describe the fundamentals of dimensional and geometrical tolerances;
2. Measure length and angles using line-graduated instruments, i.e. vernier callipers, micrometers, bevel protractor, sine bar and surface plates;
3. Use comparative length-measuring instruments, i.e. dial indicator, to measure variations in the distance between two or more surfaces

COURSE CONTENT

Measurements on precision instruments; sine bar, CMM - Universal measuring microscope,
Profile projector - Electronic comparator, optical flat, surface roughness - Gear tooth thickness - MAAG gear tester - Calibration of LVDT - Statistical Quality Control charts.

COURSE OUTCOMES

At the end of the course student will

1. Illustrate on different metrological tools and perform measurements in quality impulsion.
2. Describe and explain the working of precision instruments.
3. Outline of electronic comparator, optical flat, surface roughness, gear thickness measuring instruments.
4. Demonstrate the statistical quality control chart.
5. Distinguish with the different instruments that are available for linear, angular, roundness and roughness measurements.
6. Locate appropriate measuring instrument according to a specific requirement.
COURSE LEARNING OBJECTIVES

1. To equip students with understanding of the fundamental principles of dynamics.
2. To develop a model of a mechanical system using a free body diagram.
3. To develop equations of motion for translational and rotational mechanical systems.

COURSE CONTENT

1. Measurement of moment of inertia of rigid bodies.
2. Gyroscope.
3. Linear vibration.
4. Torsional vibration.
5. Balancing.
6. Geared system

COURSE OUTCOMES

At the end of the course student will
1. Compute the moment of inertia of rigid bodies
2. Demonstrate the working principles of gyroscope.
3. Experiment with vibrations and balancing.
COURSE LEARNING OBJECTIVES

1. To understand various components of automobile engines.
2. To impart knowledge in the assembling and dismantling of any vehicles and its sub-systems.
3. To Develop students with skills needed for troubleshooting the practical automobile problems.

COURSE CONTENT

1. Study on garage tools and equipments.
2. Experiments on the cleaning & greasing of automobiles.
3. Experiments on the quality of lubrication oil and maintenance.
4. Experiments on the condition of battery quality and maintenance.
5. Experiments on the diagnostic of an Electronic Control Unit (ECU) of an automobile.
6. Dismantling of two / four stroke engine and bring back to the working condition.
7. Dismantling & assembly of Clutch (light / heavy duty vehicle).
8. Dismantling & assembly of Constant mesh gearbox and synchromesh gearbox.
12. Experiments on Wheel balancing and Wheel Rotation.
13. Inspection of Tyre wear pattern and verification of Wheel alignment.
15. Driving Cycle Analysis using Chassis Dynamometer.

COURSE OUTCOMES

At the end of the course student will be able to

1. Identify different automotive systems and subsystems
2. Ability to dismantle and assemble engine, transmission, steering, suspension, braking, electrical and electronics systems.
3. Illustrate working and functions of various automotive components.
IV. ELECTIVE COURSES

a. PROGRAMME ELECTIVE (PE)

MEPE10 – COMPRESSIBLE FLOW AND JET PROPULSION

<table>
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<th>Course Code:</th>
<th>MEPE10</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Compressible Flow and Jet Propulsion</td>
<td>Prerequisite:</td>
<td>MEPC14</td>
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COURSE LEARNING OBJECTIVES

1. To familiarize with the differences between incompressible and compressible flows.
2. To draw the connection between compressible flow and thermodynamics.
3. To provide knowledge on various types of shocks.
4. To impart knowledge on the effect of friction and heat transfer on compressible flows.
5. To impart skills to analyze engines used for jet propulsion.

COURSE CONTENT

Fundamentals: Governing equations for inviscid-compressible flows - static and stagnation properties - speed of sound and Mach number, continuity, momentum and energy equations, mathematical derivations of Bernoulli’s equation for incompressible and compressible fluid flows, effects of compressibility on the fluid flow measurements, application incompressible fluid flow standard tables.

Isentropic flows: through variable area passage ducts - Flow through nozzles and diffusers, chocked flow, critical pressure ratio, application of equation of critical pressure ratio, variable cross-sectional area flow.


REFERENCE BOOKS:

3. Radhakrishnan, E., Gas Dynamics, Pub. PHI Learning
4. Radhakrishnan, E., Applied Gas Dynamics, Pub.: Wiley India
6. Anderson, J. D., Modern Compressible Flow with Historical Perspective, Pub.: Mc Graw-Hill Education

COURSE OUTCOMES:

At the end of the course student will
1. Be able to identify, appreciate and analyze the compressible fluid flow problems by applying the fundamental technologies of fluid mechanics.
2. Analyze compressible flow problems with constant area & converging / diverging ducts, fluid flow with shocks, heat transfer and frictional effects.
3. Interpret and analyze the performance characteristics of jet propulsion engines.

MEPE11 – COMPUTATIONAL FLUID DYNAMICS

<table>
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<th>Course Code:</th>
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<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Computational Fluid Dynamics</td>
<td>Prerequisite:</td>
<td>MEPC14</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To introduce numerical modeling and its role in the field of heat transfer and fluid flow.
2. To enable the students to understand the various discretization methods and solving methodologies.
3. To create confidence to solve complex problems in the field of heat transfer and fluid dynamics by using high speed computers

COURSE CONTENT


Important Consequences of Discretization of Time Dependent Diffusion Type Problems: Consistency, Stability, Convergence, Grid independent and time independent study, Stability analysis of parabolic and hyperbolic equations. Finite Volume Discretization of 2-D unsteady State Diffusion type problems.

Solution of Systems of Linear Algebraic Equations: Criteria for unique solution, infinite number of solutions and no solution, Solution techniques for systems of linear algebraic equations: Elimination, Iteration and Gradient Search methods with examples. Norm of a vector, Norm of a matrix, some important properties of matrix norm, Error analysis of elimination methods.


REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will
1. Express numerical modeling and its role in the field of fluid flow and heat transfer.
2. Estimate the various errors and approximations associated with numerical techniques.
3. Apply the various discretization methods and solution procedures to solve flow and heat transfer problems.
4. Be able to evaluate the best method for a given thermo-fluids problem.
**MEPE12 – ADVANCED IC ENGINES**

<table>
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<th>Course Code:</th>
<th>MEPE12</th>
<th>No. of Credits:</th>
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<tr>
<td>Course Name:</td>
<td>Advanced IC Engines</td>
<td>Prerequisite:</td>
<td>MEPC17</td>
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</table>

**COURSE LEARNING OBJECTIVES**

1. Apply principles of thermodynamics, fluid mechanics, and heat transfer to the design and analysis of engines and engine components.
2. Become aware of the relevance of environmental and social issues on the design process of internal combustion engines.
3. Develop mathematical methods for designing components and systems
4. Apply numerical methods to perform design calculations.
5. Advance proficiency in professional communications and interactions.

**COURSE CONTENT**


**Engine Testing and Measurement Systems:** Transient dynamometer, Test cells, chassis dynamometer, Fuel and air flow measurement and conditioning system, in-cylinder pressure transducers and crank angle encoders. Driving cycles for emission measurement, National and International emission Norms, Methods and principles of emission measurement – Non dispersive infrared gas analyzer, gas chromatography, chemiluminescent analyzer and flame ionization detector, smoke meters and soot analyzer

Combustion Visualization: Optical Engine, Endoscopic access & optical chambers – In-cylinder flow measurements: Particle image velocimetry, Laser Doppler Anemometry – In-cylinder fuel and species measurement; Planar Laser induced Fluorescence, Raman and Rayleigh Scattering Techniques – Fuel injection and Spray characteristics - Phase Doppler particle analyzer, Mie scattering, Laser sheet droplet sizing – Schlieren and shadowgraphy techniques & Chemi-luminescence Imaging

REFERENCE BOOKS:

2. Fundamentals of internal combustion engines: Gill, Smith and Ziurys, Oxford and IBH.
4. Internal Combustion Engines and Air Pollution: E F Obert, Intext Educational Publishers, NY.

COURSE OUTCOMES

At the end of the course student will be able to
1. Understand the combustion phenomena in SI and CI engines.
2. Explain the advanced combustion concepts used to increase engine efficiency and reduce emission levels
3. Understand the different mechanism of different subsystem used in an engine test bed facility
4. Explain the advanced imaging techniques used to study the combustion and spray characteristics of the fuel.
5. Identify the exhaust pollutants formation and measurement techniques.

MEPE13 – COMBUSTION ENGINEERING

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<th>Course Code:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Combustion Engineering</td>
<td>Prerequisite:</td>
<td>MEPC17</td>
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</table>

COURSE LEARNING OBJECTIVES

1. This course starts with a review of chemical thermodynamics, statistical mechanics, equilibrium chemistry, chemical kinetics, and conservation equations.
2. Then the following subjects are covered: chemical and dynamic structure of laminar premixed, diffusion, and partially premixed flames; turbulent premixed combustion; turbulent diffusive combustion in one and two-phase flows;
3. Aerodynamics and stabilization of flames; ignition, extinction and combustion instabilities; non-intrusive combustion diagnostics and flame spectroscopy.

COURSE CONTENT


Chemical kinetics- Reaction rates- Chemical Mechanisms- Coupling chemical & Thermal analyses of reacting systems.

Simplified Conservation equations for reacting flows- continuity - Momentum Conservation - Energy Conversation - Diffusion equations. General characteristics of combustion, explosion and detonation


Turbulent Premixed & Non premixed flames - Droplet evaporation and burning – Combustion of carbon particle

REFERENCE BOOKS:

2. Principles of Combustion by Kenneth Kuo, John Wiley
4. Combustion Theory by F. A. Williams, ABP
5. Understanding Combustion by H.S. Mukunda, Macmillan India

COURSE OUTCOMES

At the end of the course student will be able to
1. Formulate combustion equations to determine A/F, adiabatic flame temperature and pollutant concentration.
2. Understand the difference between premixed and diffusion combustion.
3. Learn the thermo-chemistry and kinetics of combustion for different fuels
4. Identify factors responsible for laminar and turbulent flame propagation.
5. Apply the different principles of flame stabilization and ignition to design combustor.
Course Code: MEPE14  
No. of Credits: 03
Course Name: Biofuels  
Prerequisite: -Nil-

COURSE LEARNING OBJECTIVES

1. To characterize different biomass feedstock’s based on its constituents and properties & understand the analytical techniques to characterize biomass.
2. To Understand and evaluate various biomass pre-treatment and processing techniques in terms of their applicability for different biomass types.
3. To provide students with the basic principles of biofuels and bioenergy systems design.
4. To identify biofuels and bioenergy sources; describe biofuels and bioenergy technologies,
5. To distinguish applications and efficiency; analyze biofuels and bioenergy manufacturing, distribution and integration issues.

COURSE CONTENT


Biomass pre-treatment: Acid/alkali treatment, steam explosion, ammonia fibre expansion, enzymatic, ball milling, other non-conventional techniques, choice of pre-treatment based on biomass types. Pellets made from wood or grass biomass are commercially available at stores for heating homes, schools, businesses.

Seed-based biodiesel, bioethanol, conversion of waste oil to biodiesel, advanced biofuels including algae-biofuel, microbial biofuel, Conversion of waste vegetable oil into biodiesel, and advanced innovations in enzymatic conversion of non-food feed-stocks. Fuel properties, engine applications.

Biomass conversion technologies for biofuel. Thermochemical processes: Combustion, gasification, pyrolysis, hydrothermal liquefaction, hydropyrolysis, torrefaction, choice of thermal process based on biomass type and product requirement.

Biofuels/energy related environmental, economics, & social issues. The source, processing, and social impacts of biofuel utilization

REFERENCE BOOKS:

7. Understanding clean energy and fuels from biomass, H. S. Mukunda, 2011

COURSE OUTCOMES

At the end of the course student will be able to
1. Describe the nature and principle of different biomass energy extraction systems and know how to choose the suitable biomass fuels for different bio-energy applications;
2. Address the desirable features of these biomass energy sources and their advantages over traditional fuels such as coal and oil
3. Identify their limited scope in terms of suitable sites, dependence on the elements, capital costs, and cost effectiveness compared with traditional sources

MEPE15 – REFRIGERATION AND AIR CONDITIONING

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<th>MEPE15</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Refrigeration and Air Conditioning</td>
<td>Prerequisite:</td>
<td>MEPC17</td>
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COURSE LEARNING OBJECTIVES

1. To understand the principles of refrigeration and air conditioning.
2. To calculate the cooling load for different applications.
3. To select the right equipment for a particular cooling application.
4. To design and implement refrigeration and air conditioning systems using existing standards.
5. Energy Conservation and Management.

COURSE CONTENT


Analysis of Vapour compression cycle, Modifications to basic cycle. Multi pressure systems. Multi-evaporator system and Cascade systems.


Air-conditioning systems – discussion about the central plant with direct evaporator and chiller applications, Ice plant, refrigerators. Food preservation, IQF technique and freeze drying etc. Cold storage and thermal insulation.

REFERENCE BOOKS:

1. Arora, R.C., Refrigeration and Air Conditioning, PHI Pvt Ltd, 2010

COURSE OUTCOMES

At the end of the course student will
1. Illustrate the basic concepts of refrigeration system.
2. Analyze the vapour compression cycle and interpret the usage of refrigerants.
3. Explain the components of vapour compression system.
4. Demonstrate the use of psychrometry in analyzing refrigeration systems.

MEPE16 – FUNDAMENTALS OF HVAC SYSTEMS

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<th>Course Code:</th>
<th>MEPE16</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Fundamentals of HVAC Systems</td>
<td>Prerequisite:</td>
<td>MEPC17</td>
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COURSE LEARNING OBJECTIVES

1. To learn climate variation and its effects on the building heat load.
2. To learn building material characteristics and their influence on building heating /cooling load for all weather conditions.
3. To study various conversation techniques related to build environment and codes for the same.

COURSE CONTENT

Introduction to Air Conditioning and Refrigeration – Basic Thermodynamics of HVAC, Types of Refrigeration Systems, the Refrigeration Cycle, Refrigerants and their Properties, Plotting the Refrigeration Cycle, Piping and Tubing, Soldering and Brazing, Refrigerant Leak Testing, Refrigerant System Evacuation, Refrigerant System Charging, Control Systems.


REFERENCE BOOKS:

2. Automotive heating and Air-conditioning, Mike Stubblefield and John H Haynes
3. Heating ventilation and air conditioning – Jan F. Kreider
4. Control systems for Heating, ventilating and air conditioning, Roger W. Haines, Springer
5. HVAC Equations, Data, and Rules of Thumb - Arthur A. Bell Jr., PE, McGraw-Hill

COURSE OUTCOMES

At the end of the course student will

1. Estimate heating loads, space heat gains and space cooling loads using accepted engineering methods.
2. Determine the coil loads for cooling and heating systems.
3. Select equipment and design systems to provide comfort conditions within the building.

MEPE17 – CRYOGENIC ENGINEERING

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<th>Course Code:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Cryogenic Engineering</td>
<td>Prerequisite:</td>
<td>MEPC17</td>
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COURSE LEARNING OBJECTIVES

1. To builds a solid foundation in the fundamentals of cryogenics
2. To encourage a “hand’s – on” approach to solving cryogenic problems
3. To provide update cryogenic information
COURSE CONTENT

Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Applications of Cryogenics - Space Programs, Superconductivity, Cryo Metallurgy, Medical applications.


J.T.Cryocoolers, Stirling Cycle Refrigerators, G.M. Cryocoolers, Pulse Tube Refrigerators Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators


REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will

1. Introduce the working principles of basic methods to achieve low temperature by using adiabatic expansion, provide a thorough understanding of applications.
2. Able to apply classical thermodynamics to different cryogenic technologies, gas separation and purification system, and low power cryocoolers.
3. Understand the functions and working principles of insulations and various low temperature measuring and storage devices.
4. Understand the application of Cryogenic technology in engineering research and Industry.
COURSE LEARNING OBJECTIVES

1. Understand how basic nano systems work
2. Use physical reasoning to develop simple nanoscale models to interpret the behaviour of such physical system
3. Understand the major issues in producing a sustainable nanotech industry

COURSE CONTENT

Introduction to the course, Historical perspective of micro and nano manufacturing technology, Advantages and applications of nanotechnology

Materials overview, atomic structure, bonding, polymers, electrical characteristics, periodic table, crystal structures and defects, physical chemistry of solid surfaces, Introduction to Si-based materials, Ge-based materials, nanomaterials preparation.

Overview of Nano Fabrication Methods: Top-down and bottom-up approaches, lithography, deposition, CVD - Basics related to nucleation and crystal growth mechanism, PVD, ALD, etching, and material modification methods, processes and equipment, Characterization Tools, Optical microscopy, Profilometry, Ellipsometry, Spectrophotometer, Scanning Electron Microscope, AFM, FFM.

Zero dimensional Nano structures (Nano Particles) - Fabrication procedures, sol-gel processing, applications, properties and applications of Nano Particles, One dimensional Nano structures - Nano wires and nano rods, fabrication methods, Properties and applications of Nano Wires, nano fluids, Two dimensional nano structures.

Top down fabrication procedures, Lithography, Pattern transfer methods, Wet Etching and Dry etching, Nano material characterization methods, Application of nano materials, Carbon Nano Tubes, Quantum dots, thermal insulation, Organic compounds and bio-applications of nano materials.

REFERENCE BOOKS:

COURSE OUTCOMES

At the end of the course student will
1. Demonstrate a working knowledge of nanotechnology principles and industry applications.
2. Explain the nanoscale paradigm in terms of properties at the nanoscale dimension.

MEPE19 – VEHICLE DYNAMICS

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<tbody>
<tr>
<td>Course Name:</td>
<td>Vehicle Dynamics</td>
<td>Prerequisite:</td>
<td>MEPC22</td>
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COURSE LEARNING OBJECTIVES

1. In-depth understanding of specialist bodies of knowledge within the engineering discipline
2. Application of established engineering methods to complex engineering problem solving
3. Fluent application of engineering techniques, tools and resources

COURSE CONTENT


Wheel hop, wheel wobble, wheel shimmy. Choice of suspension spring rate. Calculation of effective spring rate. Vehicle suspension in fore and apt directions. Ride characteristics of tyres, behaviour while cornering, power consumed by tyre, effect of driving and braking torque-Gough's tyre characteristics.


Calculation of tractive effort and reactions for different drives-Stability of a vehicle on a slope, on a curve and a banked road.


REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will
1. Develop physical and mathematical models to predict the dynamic response of vehicles;
2. Apply vehicle design performance criteria and how to use the criteria to evaluate vehicle dynamic response;
3. Modify a model of a vehicle to enable it to meet design performance criteria;

MEPE21 – DYNAMICS OF MACHINERY

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<th>Course Code:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Dynamics of Machinery</td>
<td>Prerequisite:</td>
<td>MEPC20</td>
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COURSE LEARNING OBJECTIVES

1. To understand the force-motion relationship of components subjected to external forces
2. To analyze the force-motion characteristics of standard machine elements
3. To study the undesirable effects of unbalances resulting from prescribed motions in mechanism.
4. To understand the importance of damping
5. To reduce the physical vibratory system into spring and damping elements

COURSE CONTENT

Free damped vibrations: viscous damping-coulomb damping.


Two degree of freedom systems – free-undamped, forced, coupling, introduction to multi-DOF systems.


Vibration of plates and membranes, modal analysis, Wave and Euler equations, numerical methods.
REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will
1. State the single degree of freedom systems.
2. Sketch the impulse response for a periodic excitation.
3. Examine the concept of forced vibration.
4. Extend the concept to two degree of freedom systems.
5. Manipulate the vibration of continuous systems.

MEPE22 – MEMS DEVICES – DESIGN AND FABRICATION

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<tbody>
<tr>
<td>Course Name:</td>
<td>MEMS Devices – Design and Fabrication</td>
<td>Prerequisite:</td>
<td>MEPC13</td>
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COURSE LEARNING OBJECTIVES

1. To think in a unified way about interdisciplinary Microsystems
2. Understand the material properties, fabrication technologies, basic structural mechanics, sensing and actuation principles, circuit and system issues, packaging, calibration, and testing.
3. Understand the operation of a wide range of sensors and actuators appropriate for microscale systems.
4. To design, analysis and master simulation techniques for combining a structured top-down system design approach with bottom-up constraints propagation design and simulate microsystems using behavioral modeling languages and finite element analysis.

COURSE CONTENT

Review of Mechanical concepts: Stress, Strain, Modulus of 15% Elasticity, yield strength, ultimate strength – General stress strain relations – compliance matrix. Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, diaphragms – Typical applications

Materials for MEMS and Microsystems – Silicon and silicon compounds, Gallium, Piezoelectric and piezoresistive materials, Polymers and metals

Introduction to design and modeling; Scaling laws in miniaturization; Standard microelectronic fabrication technologies - bulk micromachining - surface micromachining - bonding technologies; Related fabrication methods and creating process flows. Role of Finite Element Analysis software in MEMS.

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will

1. Understand the working principles of micro sensors and actuators
2. Understand the typical materials used for fabrication of micro systems
3. Understand the principles of standard micro fabrication techniques
4. Appreciate the challenges in the design and fabrication of Micro systems

MEPE24 – OIL HYDRAULICS AND PNEUMATICS

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<tr>
<td>Course Name:</td>
<td>Oil Hydraulics and Pneumatics</td>
<td>03</td>
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<td>Prerequisite:</td>
<td>MEPC14</td>
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COURSE LEARNING OBJECTIVES

1. The cognitive objective of this course is for each student to comprehend foundational knowledge needed to perform stated entry-level industry competencies.
2. The performance objective of this course is for each student to apply foundational knowledge to hydraulic and pneumatic problems and exercises encountered in class.

COURSE CONTENT

Basic concepts of fluid power system design - Hydraulic oils and fluid properties – Seals and Seal materials - Filters and Filtration.

Hydraulic pumps, cylinders, and motors - Construction, sizing, and selection.

Control valves; pressure, flow, and direction - Servo-valves.

Basic hydraulic circuits, hydrostatic transmission - Cartridge valve circuits.

Control of hydraulic circuits - Electrical, electronics, and PLC - Pneumatic components and basic circuits.

REFERENCE BOOKS:


COURSE OUTCOMES

1. Recall various fluid properties and identify the appropriate fluid power system for particular application.
2. Recognize the suitable pump and actuators for particular application.
3. Select various control valves such as pressure control, flow control, direction control valves and use them in hydraulic and pneumatic circuit development.
4. Analyze the hydraulic and pneumatic circuit for energy efficiency.
5. Select the appropriate control system like electrical, electronics, and PLC to control the fluid power system.
6. Trouble-shoot and identify maintenance problems associated with fluid power system.

MEPE25 – INDUSTRIAL ROBOTICS

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<tr>
<td>Course Name:</td>
<td>Industrial Robotics</td>
<td>Prerequisite:</td>
<td>MEPC13</td>
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COURSE LEARNING OBJECTIVES

1. To introduce the basic concepts, parts of robots and types of robots
2. To make the students familiar with the various drive systems for robot, sensors and their applications in robots, programming of robots
3. To discuss about the various applications of robots, justification, implementation and safety of robot.

COURSE CONTENT


Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) – Deviations and Problems. Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End effector commands, and Simple programs

RGV, AGV; Implementation of Robots in Industries – Various Steps; Safety Considerations for Robot Operations; Economic Analysis of Robots – Pay back Method, EUAC Method, Rate of Return Method.

REFERENCE BOOKS:

COURSE OUTCOMES

At the end of the course student will
1. Classify and characterize the robots based on the configuration and work volume.
2. Explain and solve the problems related to robot design and control.
3. Illustrate the working of the transmission system in a robot.
4. Discuss the concept of vision system and image processing.
5. Write programs for automatic functioning of a robot.
6. Design a working model of a robot using the concepts and principles learnt.

MEPE26 – MECHATRONICS

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<tbody>
<tr>
<td>Course Name:</td>
<td>Mechatronics</td>
<td>Prerequisite:</td>
<td>MEPC13</td>
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COURSE LEARNING OBJECTIVES

1. Apply mechanical engineering and electrical engineering knowledge and skills to problems and challenges in the areas of mechatronic engineering.
2. Integrate and use systems or devices incorporating modern microelectronics, information technologies and modern engineering tools for product design, development and manufacturing.
3. Engage in lifelong learning in their profession and practice professional and ethical responsibility.

COURSE CONTENT

Introduction to mechatronics- Historical perspective- Key elements of a mechatronic system- Examples of mechatronic systems.

Sensors and Transducers – Signal conditioning and Data acquisition systems.

Actuation systems– Pneumatic and Hydraulic system, mechanical and electrical actuation systems.

Smart materials and Systems – Piezoelectric actuators– Shape memory alloy (SMA) actuators, Magneto rheological and Electro rheological Fluids and its applications; Dampers, Clutch, Valves etc..

Introduction to microcontrollers and microprocessors– Interfacing microcontrollers with sensors and actuators – Introduction to Programmable logic controllers (PLC) – Case Studies of mechatronic systems.
REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will

1. To employ the basic mathematical skills needed to solve routine engineering problems.
2. To demonstrate knowledge of electrical circuits and logic design.
3. To implement engineering solutions and techniques to solve design problems.
4. To design mechatronic components and systems.
5. To apply spreadsheets, computer-based modeling and other computer-based methods to solve mechatronic problems.
6. To communicate through writing with others in the field of mechatronics.

MEPE27 – INDUSTRIAL TRIBOLOGY

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<tr>
<td>Course Name:</td>
<td>Industrial Tribology</td>
<td>Prerequisite:</td>
<td>MEPC18</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To impart knowledge on friction, wear and lubrication
2. To acquire knowledge on surface coatings and measurements.

COURSE CONTENT


Genesis of friction, friction in contacting rough surfaces, sliding and rolling friction, various laws and theory of friction. Stick-slip friction behavior, frictional heating and temperature rise. Friction measurement techniques.

Wear and wear types. Mechanisms of wear - Adhesive, abrasive, corrosive, erosion, fatigue, fretting, etc., Wear of metals and non-metals. Wear models - asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage. Wear in various mechanical components, wear controlling techniques.
Introduction to lubrication. Lubrication regimes. Introduction to micro and nano tribology. Coating characteristics, Coating performance evaluation, Powder coatings and types, application methods.

Surface topography measurements - Electron microscope and friction and wear measurements - Laser method. Sliding friction and wear abrasion test, rolling contact and fatigue test, solid particle and erosion test, Use of transducers and instruments in Tribology

REFERENCE BOOKS:


COURSE OUTCOME

At the end of the course student will
1. Apply the knowledge of tribology in industries
2. Identify the types of wear
3. Know the working of surface measuring instruments

MEPE29 – RENEWABLE ENERGY SOURCES

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<tr>
<td>Course Name:</td>
<td>Renewable Energy Sources</td>
<td>Prerequisite:</td>
<td>MEPC17</td>
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COURSE LEARNING OBJECTIVES

1. To enable the students to understand the principle of working and the components of different non-conventional sources of energy and their utilization.
2. To get an exposure to the wind energy, Biomass, geothermal energy, tidal energy, fuel cells and energy conversion technologies.

COURSE CONTENT


REFERENCE BOOKS


COURSE OUTCOMES

At the end of the course student will
1. To estimate solar radiation and formulate heat transfer equations and analyze of modern energy conversion technologies
2. To describe various renewable energy resources and techniques to utilize them effectively.
4. Describe and analyze photovoltaic systems.
5. Explain the energy harvesting methods from various energy sources.
6. Distinguish the various form of energies such as magneto hydrodynamic, thermionic and fuel cell.
MEPE30 – CONTINUUM MECHANICS

Course Code: MEPE30  No. of Credits: 03  Prerequisite: MEPC12
Course Name: Continuum Mechanics

COURSE LEARNING OBJECTIVES

1. To introduce basic tensorial calculus for understanding continuum behavior of matters.
2. To familiarize the configuration dependent stress and strain measures.
3. To strengthen the knowledge about the fundamental balance principles of continuum objects.
4. To establish a good foundation in constitutive modeling

COURSE CONTENT

**Tensor algebra:** Scalar, Vector, second and higher order Tensors, Eigen values & vectors, Transformation of Tensors, Tensor valued functions, gradient operators and Integral theorems.

**Kinematics:** References and deformations configurations, Mapping and deformation gradients, material and spatial representations, Nanson’s formula, Strain measures, Rotation & stretch tensors, rate of deformation.

**Kinetics:** Concept of stress, Cauchy’s stress theorem, first and second Piola- Kirchoff’s & Cauchy’s stress tensors, Normal and shear stress, Extremal stress values, stress states.

**Balance Principles:** Mass conservation, Reynold’s transport theorem, Momentum and energy balances in references and current configuration, Weak and strong forms of balance equation, Continuum thermodynamics, Clausius-Duhem inequality, Frame dependent and independent quantities, Objective rates.

**Constitutive Modeling:** Fluid and solid constitutive equations, generalized Hooke’s law, material symmetry, visco elasticity, metal plasticity: Yield criteria, Flow rule, Hardening rule, loading & unloading conditions, multiplicative strain decomposition, rheological models.

**REFERENCE BOOKS:**

COURSE OUTCOMES

Upon completion of this course, the student will be able to:
1. Understand the unified theory of continuum body such as fluids and solids.
2. Knowledge of stress and strain at a particular configuration on a material and spatial point.
3. Ability to perceive the constitutive modeling of materials.

MEPE31 – MATHEMATICAL METHODS FOR MECHANICAL ENGINEERS

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<tr>
<td>Course Name:</td>
<td>Mathematical Methods for Mechanical Engineers</td>
<td>Prerequisite:</td>
<td>MAIR43</td>
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COURSE LEARNING OBJECTIVES

1. To understand ordinary and partial differential equations from engineering point of view
2. To solve differential equations encountered in mechanical engineering using different analytic, semi-analytic and numerical methods
3. To apply the principles of variational calculus to solve problems encountered in mechanical engineering
4. To introduce applications of different mathematical functions in mechanical engineering problems.

COURSE CONTENT

Ordinary differential equations – variation of parameters, Frobenius method, Sturm-Liouville problems, Bessel and Legendre functions, Green’s function, Perturbation methods

Partial differential equations – well-posed problem, separation of variables – series solution, use of transforms and complex numbers, Green’s identity and method

Variational calculus – Euler-Lagrange equation – applications, Lagrange multipliers, method of weighted residues

Special functions – understanding beta, gamma and error functions with examples from mechanical engineering

Numerical methods for differential equations – Conversion of differential equation into system of algebraic equations – finite difference method, methods of solution – matrix inversion, Gauss elimination, TDMA, Iterative methods and gradient search methods
REFERENCE BOOKS:


COURSE OUTCOMES

1. To analyze and solve differential equations encountered by mechanical engineers using analytic, semi-analytic and numerical methods.
2. To understand the important of special functions in mechanical engineering problems.
3. To use variational calculus principles to analyze and extremize problems.

MEPE32 – TWO PHASE FLOW AND HEAT TRANSFER

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<tr>
<td>Course Name:</td>
<td>Two Phase Flow and Heat Transfer</td>
<td>Prerequisite:</td>
<td>MEPC19</td>
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COURSE LEARNING OBJECTIVES

1. To understand two phase flow in a variety of engineering processes.
2. To understand the applications of various experimental heat transfer correlations in engineering applications.

COURSE CONTENT

Introduction to two phase heat transfer, Continuity, momentum and energy equations, substantial acceleration, temperature distribution in internal flows, relations between thermal boundary layer and hydrodynamic boundary thickness using magnitude analysis, two phase heat transfer in variety of engineering processes.

Droplet condensation, falling film condensation, Nusselt theory. Nucleate boiling, convective boiling with pure fluids, critical heat flux boiling.

Two phase heat transfer in mixtures, temperature Glide, heat transfer coefficient estimation, presence of low vapor-pressure liquid, non-condensing gas, Melting and solidification;

REFERENCE BOOKS:


COURSE OUTCOMES

• Explain and apply the concepts of two-phase heat transfer
• Estimate the two-phase heat transfer coefficients
• Determine and compute two phase pressure drops and heat losses.

MEPE33 – THEORY OF SPRAYS

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<tr>
<td>Course Name:</td>
<td>Theory of Sprays</td>
<td>Prerequisite:</td>
<td>MEPC14</td>
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COURSE LEARNING OBJECTIVES

1. To understand the spray and atomization characteristics of different atomizers
2. To analyze the different approaches adopted for atomization mechanism
3. To familiarize the methods adopted for understand spray pattern and drop sizing

COURSE CONTENT


Spray characteristics – Spray properties, Penetration, cone angle, radial and circumferential liquid distribution and drop drag coefficient. Droplet Evaporation – Steady state and unsteady state analysis
droplet lifetime and burning. Drop sizing – Factors – Methods: Mechanical, Electrical and optical Methods

Atomizers – requirements – Pressure, Rotary, Air-assist, Air blast, Effervescent, Electrostatic and Ultrasonic Atomizers – flow and performance relationships

REFERENCE BOOKS


MEPE34 – ADDITIVE MANUFACTURING

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<tr>
<td>Course Name:</td>
<td>Additive Manufacturing</td>
<td>Prerequisite:</td>
<td>MEPC16</td>
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COURSE LEARNING OBJECTIVES

To imbibe knowledge on

1. Development of Additive Manufacturing (AM) and opportunities for product development.
2. Acquaint with software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
3. Familiarize with VAT polymerization and material extrusion processes, powder bed fusion and direct energy deposition.
4. Applications of binder jetting, material jetting and laminated object manufacturing processes

COURSE CONTENT


**REFERENCE BOOKS**


**COURSE OUTCOMES:**

On completing this course students will be able to:

1. Recognize the development of AM technology and opportunities for transforming a concept into product development.
2. Elaborate the vat polymerization and material extrusion processes and its applications.
3. Acquire knowledge on process and applications of powder bed fusion and direct energy deposition.
4. Evaluate the advantages, limitations, applications of binder jetting, material jetting and laminated object manufacturing processes.
MEPE35 – COMPUTER AIDED DESIGN AND DRAFTING

Course Code: MEPE35  
No. of Credits: 03
Course Name: Computer Aided Design and Drafting  
Prerequisite: MEIR12

COURSE LEARNING OBJECTIVES

1. To introduce the student to the basic tools of computer-aided design (CAD) and computer-aided manufacturing (CAM).
2. To expose the student to contemporary computer design tools for aerospace and mechanical engineers.
3. To prepare the student to be an effective user of a CAD/CAM system.

COURSE CONTENT

CAD hardware - Product cycle - CAD tools, CAD systems; system evaluation, CAD specific I/O devices.

CAD software - Graphic standards – Modes of graphics operation, Software Modules.

Geometric modeling – Types and mathematical representation and manipulation of curves and surfaces.

Solid modeling- fundamentals, feature based modeling manipulations of solid models. Transformation of Geometric models and visual realism - Animation.

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will

1. Explain lifecycle of a product and the role of computer-aided design (CAD) in product development.
2. Describe the concepts of geometric and solid modelling.
3. Visualize geometric models through animation and transform them into real world systems.
MEPE36 – POWER PLANT ENGINEERING

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<tr>
<td>Course Name:</td>
<td>Power Plant Engineering</td>
<td>Prerequisite:</td>
<td>MEPC17</td>
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**COURSE LEARNING OBJECTIVES**

1. Describe sources of energy and types of power plants
2. Analyze different types of steam cycles and estimate efficiencies in a steam power plant
3. Describe basic working principles of gas turbine and diesel engine power plants. Define the performance characteristics of such power plants
4. List the principal components and types of nuclear reactors.

**COURSE CONTENT**


Gas turbine power plants – Thermodynamic fundamentals, application, combined cycle configurations, cogeneration, major components, factors influencing performance of GT plants.


Diesel power plants – layout – working, Different systems – Fuel system, lubrication system, Air intake system, Exhaust system, cooling system. Starting system.


**REFERENCE BOOKS**


**COURSE OUTCOMES**

At the end of the course student will

1. Summarize the layout and components in a power plant.
2. Enumerate and classify the types of power plants available.
3. Recognize the steam cycles on pressure-volume and temperature diagram.
4. Outline the scenario of entire business of power plants along with performance parameters, load curves and tariff calculations.
5. Extend their knowledge to power plant economics and environmental hazards

MEPE37 – RADIATIVE HEAT TRANSFER

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<tbody>
<tr>
<td>Course Name:</td>
<td>Radiative Heat Transfer</td>
<td>Prerequisite:</td>
<td>MEPC19</td>
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COURSE LEARNING OBJECTIVES

1. Understands the physical mechanisms involved in radiation heat transfer. Each student can calculate total, hemispherical radiative properties of real surfaces from their spectral, directional counterparts.
2. Calculate radiation heat transfer between black body surfaces and gray body surfaces.
3. To identify, formulate, solve engineering problems and to use the techniques, skills, and modern engineering tools necessary for engineering practice

COURSE CONTENT


Shape factor - Triangular enclosure - Evaluation of shape factors - Radiation in enclosures - Electrical analogy – Applications - Non-gray enclosures - Enclosure with Specular surfaces - Integral method for enclosures.


Isothermal gas enclosures - Well-stirred furnace model - Gas radiation in complex enclosures - Interaction between radiation and other modes of heat transfer - Radiation heat transfer during flow over flat plate.

Radiation and Climate – Radiative - convective equilibrium - Radiative equilibrium with scattering - Radiation measurement - Radiation with internal heat source - Particle scattering - Scattering in the atmosphere - Non-isotropic scattering - Approximate methods in scattering - Monte Carlo method.
REFERENCE BOOKS

4. Conduction heat transfer by Schneider, Eddison Wesley.

MEPE38 – QUALITY CONTROL

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<thead>
<tr>
<th>Course Code:</th>
<th>MEPE38</th>
<th>No. of Credits:</th>
<th>03</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Quality control</td>
<td>Prerequisite:</td>
<td>Nil</td>
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</table>

COURSE CONTENT

Introduction to quality control and total quality system

Philosophies of quality control: Deming’s philosophy, Crosby’s philosophy, Juran’s philosophy. Comparison of three philosophies.

Tools for continuous quality Improvement: Pareto Diagrams, Flow charts, Cause effect diagrams, scatter plots, Multivariable charts, Failure Mode and effects criticality analysis.


Data analysis and sampling, validating distribution assumptions, transformation to achieve normality, analysis of count data, concepts of sampling

Statistical process control: Basics of Control charts, Control charts of variables, control charts for attributes, process capability analysis, acceptance sampling plans

Product and process design: Reliability, experimental design and Taguchi method

REFERENCE BOOKS:

MEPE39 – INDUSTRIAL SAFETY ENGINEERING

Course Code: MEPE37
Course Name: Industrial Safety Engineering
No. of Credits: 03
Prerequisite: Nil

COURSE LEARNING OBJECTIVES

1. To imbibe knowledge on safety management functions and its techniques.
2. To imbibe knowledge on accident reporting & investigation procedure.
3. To imbibe knowledge on safety education & training evaluation of safety performance in an organization.
4. To imbibe knowledge on workplace hazards & its control

COURSE CONTENT


Safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign

Concept of an accident, reportable and non-reportable accidents, reporting to statutory authorities


Machine Guarding, Guarding of hazards, Machine Guarding types and its application – Safety in welding and Gas cutting – Safety in Manual and Mechanical material handling- Safety in use of electricity

Toxicity- TLV- Types of Chemical Hazards-Occupational diseases caused by dust, fumes, gases, smoke and solvent hazards- control measures

Fire triangle- Types of fire - first aid firefighting equipment – flammability limit- LPG safety - Hazard identification and Risk Analysis.

Overview of factories act 1948 – ISO-45001

REFERENCE BOOKS:

Department of Mechanical Engineering, National Institute of Technology,
Tiruchirappalli


COURSE OUTCOMES

At the end of the course student will
1. Apply principles of safety management, its functions and technique in any organization,
2. Classify and categorize the factors contributing to accident,
3. Formulate accident investigation program in an organization, practice and develop accident reporting system within an organization and calculate accident indices for monitoring safety performances,
4. Apply material handling and machine guarding principles in industrial applications
5. Realize chemical hazards, toxicity, fire and explosion in the work place and involve to take various control measures to prevent hazards.

MEPE40 – OPERATIONS RESEARCH

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<th>Course Code:</th>
<th>MEPE40</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Operations Research</td>
<td>Prerequisite:</td>
<td>Nil</td>
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COURSE LEARNING OBJECTIVES

1. To provide knowledge and training in using optimization techniques for engineering problems.
2. To understand different optimization model adopted in engineering industry

COURSE CONTENT


Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models

Queueing models – Single server and multi-server models – Poisson input – Exponential service – Constant rate service – Infinite population
Department of Mechanical Engineering, National Institute of Technology, Tiruchirappalli


REFERENCE BOOKS:


COURSE OUTCOME

At the end of the course student will be able to use the optimization techniques for engineering and Business problems

MEPE41 – MECHANICAL VIBRATIONS

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<tr>
<th>Course Code:</th>
<th>MEPE41</th>
<th>No. of Credits:</th>
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<tr>
<td>Course Name:</td>
<td>Mechanical Vibrations</td>
<td>Prerequisite:</td>
<td>MEPC20</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To understand the fundamentals of vibration.
2. To develop the two degree of freedom systems.
3. To formulate the multi degree of freedom systems.
4. To study the vibration test & measurements and devise the vibration controlling methods.

COURSE CONTENT


Two degree – Normal mode analysis – Translational system - Rotor system - Lagrangian energy method - Coordinate coupling.
Multi degree - Eigen value and vector - Linear system - Matrix method - Influence coefficients - Stiffness

Experimental modal analysis - Free and Forced vibration tests - Frequency response function (FRF),
Methods of vibration control - Excitation reduction at source, Balancing of rotating machines - single
plane - double plane - Dynamic properties and Selection of structural materials - Viscoelastic materials,
Vibration absorbers - Tuned absorber - Tuned and damped absorber, Untuned viscous damper,
Vibration isolation techniques - Active control - passive control.

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will
1. Review the fundamentals of vibration and formulate the differential equations of the given
vibration models.
2. Develop the equation of motion for the two degrees of freedom system.
3. Model the equation of motion for the multi degrees of freedom system based on various
numerical methods.
4. Study the vibration tests, measurements and control of the machinery components.

MEPE42 – INTRODUCTION TO FRACTURE MECHANICS

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<th>Course Code:</th>
<th>MEPE42</th>
<th>No. of Credits:</th>
<th>03</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Introduction to Fracture Mechanics</td>
<td>Prerequisite:</td>
<td>MEPC12</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To introduce the basic concepts of fracture mechanics
2. To import knowledge on linear elastic fracture mechanics
3. To study the behaviour of the elastic plastic fracture mechanics
4. To understand the experimental testing of plain strain fracture toughness and crack repair
methodologies.
COURSE CONTENT


Linear Elastic Fracture Mechanics (LEFM) - Griffith theory, Energy release rate, Instability and R-curve, Stress analysis of cracks - Stress intensity factor, Relationship between K and global behaviour, Crack tip stress analysis.

Elastic Plastic Fracture Mechanics (EPFM) - Crack tip opening displacement (CTOD), J-integral, relationship between J and CTOD.

Experimental determination of plane strain fracture toughness, K- R curve testing, J measurement, CTOD testing, Failure assessment diagram, Crack arrest and repair methodologies.

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will
1. Understand the fundamental concepts of fracture mechanics.
2. Derive the governing equations for the linear elastic fracture mechanics
3. Formulate the relationship between J-integral and CTOD.
4. Learn to know how to experimentally testing the plain strain fracture toughness and crack repair methodologies.
# MEPE43 – THEORY OF ELASTICITY

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<tbody>
<tr>
<td>Course Name:</td>
<td>Theory of Elasticity</td>
<td>Prerequisite:</td>
<td>MEPC12</td>
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</tbody>
</table>

## COURSE LEARNING OBJECTIVES

1. To impart concept of stress and strain analysis in solids
2. To familiarize 2D problems in elasticity and its solutions
3. To imbibe knowledge of elastic problems in polar coordinates
4. To acquaint with the solution of advanced bending problems
5. To understand torsional problems in elasticity

## COURSE CONTENT

**Stress and Strain:** Introduction to stress analysis in elastic solids - Stress at a point – Stress tensor – Stress components in rectangular coordinate systems - Cauchy’s equations – Stress transformation – Principal stresses and planes - Hydrostatic and deviatoric stress components - Octahedral stress - Equations of equilibrium - Displacement field – engineering strain - strain tensor– analogy between stress and strain tensors - Strain-displacement relations – Compatibility conditions – Principal strains

**Constitutive Equations:** Generalized Hooke’s law - Stress -Strain relations for isotropic materials - Elastic constants - Relation between elastic constants - St. Venant’s principle for end effects – Uniqueness theorem - Castigliano’s Theorem.

**2D Problems in Elasticity:** Plane stress and plane strain problems – Stress compatibility equation - Airy’s stress function and equation – Polynomial method of solution – Solution for bending of a cantilever beam with an end load.

**Elastic Problems in Polar Coordinates:** Analogy between polar and rectangular coordinates – Equilibrium equations – Airy’s stress function in polar coordinates – Application in Stress Concentration problems – Axisymmetric problems – Thick walled cylinder and rotating discs.

**Unsymmetrical bending:** Unsymmetrical bending of straight beams – Curved beams - Shear center of thin walled open sections with one axis of symmetry.

**Torsion:** Torsion of non-circular bars - Solutions for circular and elliptical cross-sections using St. Venant’s theory and Prandtl’s method – Torsion of thin walled tubes – Shear flow.

## REFERENCE BOOKS


COURSE OUTCOMES

At the end of the course, the student will be able to:
1. Apply concepts of stress and strain analyses in solids.
2. Solve 2D problems in elasticity.
3. Estimate the stress field in axisymmetric problems.
4. Solve general bending problems.
5. Solve torsional problems of arbitrary cross sections.

MEPE44 – INDUSTRIAL NOISE AND VIBRATION CONTROL

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<th>Course Code:</th>
<th>MEPE44</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Industrial Noise and Vibration Control</td>
<td>Prerequisite:</td>
<td>MEPC14, MEPC17</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To understand the fundamentals of noise and vibration control.
2. To familiarize with the measurements of noise and vibration.
3. To introduce the practices of design for quietness.

COURSE CONTENT

Noise and its measurement
Waves as moving disturbances; frequency range of human ear and human speech; octave and one-third octave bands; plane waves; spherical waves, wave solution, wave character; sound power level, intensity level, sound pressure level, particle velocity, far field and near field, inverse square law; anti-logarithmic addition and subtraction of levels; A-weighting; sound level meter, intensity meter, etc.

Vibration and its measurement
Oscillation, basic dynamical elements, state variables; degrees of freedom; single DOF system; damping; Multi-DOF system, transmissibility, computation of natural frequencies and modes; critical speeds, electromechanical and electro-acoustic analogies; electrical analogous circuits; principle of impedance mismatch; accelerometer and vibrometer, instrumentation for vibration measurements.

Vibration Control
Vibration isolators; dynamic absorbers; damping and dampers; impedance mismatch; control of structure-borne sound; free-layer damping and constrained-layer damping; vibration control at the source; active vibration control; shock absorber.
Acoustic enclosures, hoods, wrappings and barriers
Basic principles; insertion loss, noise reduction and transmission loss; flanking transmission; acoustic leaks; acoustic lagging.

Mufflers and Silencers
Silencer performance metrics; silencer selection factors; electroacoustic modelling; cascading of muffler elements; multiply connected mufflers; dissipative silencers; acoustic materials; combination mufflers; pressure drop considerations; break-out noise.

Strategies for noise control
Control of noise at the source, in the path, and at the receiver end; noise control of an existing facility; environmental impact assessment (EIA)

REFERENCE BOOKS:


COURSE OUTCOMES

1. The fundamentals and applications taught in this course will prepare the students to work on project works related with Noise and Vibration Control
2. Students will be acquainted with knowledge of Noise and Vibration Control to work as NVH (Noise, Vibration and Harshness) Engineers.
b. OPEN ELECTIVE

MEOE11 – FINITE ELEMENT METHOD

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<th>Course Code:</th>
<th>MEOE11</th>
<th>No. of Credits:</th>
<th>03</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Finite Element Method</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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</table>

COURSE LEARNING OBJECTIVES

1. The objective of the course is to apprise the students about the basics of the Finite Element Technique, a numerical tool for the solution of different classes of problems in solid mechanics.
2. Different application areas will be dealt with after introducing the basic aspects of the method.
3. The analysis methodologies for 1-D, 2-D and 3-D problems with the advantages and disadvantages clearly spelt out.
4. It is expected that once the students are exposed to the course, they will be in a position to develop computer codes for any physical problem usingFinite Element technique.

COURSE CONTENT


One-dimensional finite element analysis; bar element, beam element, frame element - Heat transfer problems.

Two-dimensional finite element analysis; types of elements, shape functions, natural coordinate systems.

Applications to structural mechanics - Numerical integration - Solution of finite element equations.

Fluid flow problems - Dynamic problems.

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will

1. Illustrate the basic concepts of finite element systems through spring systems and by solving problems.
2. Interpret one-dimensional and two-dimensional finite element analysis with examples.
3. Apply finite element methods to real world problems and obtain solutions.
MEOE12 – COMPOSITE MATERIALS

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<th>Course Code:</th>
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<th>No. of Credits:</th>
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<tr>
<td>Course Name:</td>
<td>Composite Materials</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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</table>

COURSE LEARNING OBJECTIVES

To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.

COURSE CONTENT


Hooke’s law for orthotropic and anisotropic materials-Lamina stress-strain relations referred to natural axes and arbitrary axes.

Governing equations for anisotropic and orthotropic plates- Angle-ply and cross ply laminates-Analysis for simpler cases of composite plates and beams - Interlaminar stresses.


Netting analysis- Failure Criteria-Flexural rigidity of Sandwich beams and plates – composite repair-AE technique.

REFERENCE BOOKS:

COURSE OUTCOMES

At the end of the course student will
1. Given a type of material, be able to qualitatively describe the bonding scheme and its general physical properties, as well as possible applications.
2. Given a type of bond, be able to describe its physical origin, as well as strength. Be able to qualitatively derive a material's Young's modulus from a potential energy curve.

MEOE15 – OPTIMIZATION IN ENGINEERING DESIGN

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<tr>
<th>Course Code:</th>
<th>MEOE15</th>
<th>No. of Credits:</th>
<th>03</th>
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</thead>
</table>
| Course Name:    | Optimization in Engineering Design | Prerequisite: | -NIL-

COURSE LEARNING OBJECTIVES

1. Earn how MSDO can support the product development process of complex, multidisciplinary engineered systems
2. Learn how to rationalize and quantify a system architecture or product design problem by selecting appropriate objective functions, design parameters and constraints
3. Subdivide a complex system into smaller disciplinary models, manage their interfaces and reintegrate them into an overall system model

COURSE CONTENT

Introduction - Optimization techniques.

Single and multi-variable optimization.

Constrained optimization.

Specialized algorithms - Integer, geometric.

Nontraditional algorithms.

REFERENCE BOOKS:

COURSE OUTCOMES

At the end of the course student will
1. Enumerate the necessity of optimization in engineering design.
2. Identify the various optimization techniques pertaining to design oriented problems.
4. Formulate constrained optimization problems.
5. Distinguish between integer and geometric specialized algorithm
6. Apply non-traditional algorithms for optimization of typical problems requiring their application.

MEOE17 – ENERGY CONSERVATION AND MANAGEMENT

<table>
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<th>Course Code:</th>
<th>MEOE17</th>
<th>No. of Credits:</th>
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<tr>
<td>Course Name:</td>
<td>Energy Conservation and Management</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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COURSE LEARNING OBJECTIVES

1. To learn the present energy scenario and the need for energy conservation
2. To understand the monitoring / targeting aspects of Energy
3. To study the different measures for energy conservation and financial implications of various thermal utilities

COURSE CONTENT


Energy Performance Assessment for Equipment and Utility systems -Boilers-Furnaces Cogeneration, Turbines (Gas, Steam)- Heat Exchangers-Electric Motors and Variable Speed Drives-Fans and Blowers-Water Pumps-Compressors

REFERENCE BOOKS:


COURSE OUTCOMES

1. Students will be familiar with Energy Conservation scenario in general and will be mastering the thermal energy auditing technologies/procedures
2. Financial aspects also will be made clear to them as far as Energy Conservation Schemes are concerned. In short, students will become knowledgeable on techno – economic aspects of Energy Conservation

MEOE18 – ENERGY STORAGE TECHNOLOGY

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<th>MEOE18</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Energy Storage Technology</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To develop the ability to understand/analyse the various types of energy storage.
2. To study the various applications of energy storage systems

COURSE CONTENT

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications

Thermal storage – Types – Modelling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use of Transys

Fundamental concept of batteries – measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide and modern batteries for example (i) zinc - Air (ii) Nickel Hydride, (iii) Lithium Battery

Flywheel, Super capacitors, Principles & Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications

REFERENCE BOOKS:

3. Electrochemical technologies for energy storage and conversion, Ru-shiliu, Leizhang, Xueliang sun, Wiley publications, 2012

COURSE OUTCOME

Able to analyze various types of energy storage devices and perform the selection based on techno-economic view point

MEOE20 – LOW TEMPERATURE TECHNOLOGY

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<th>Course Code:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Low Temperature Technology</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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COURSE LEARNING OBJECTIVES

1. To understand the fundamental principles of refrigeration, air conditioning and cryogenics.
2. To select the right insulation for a particular cooling application.
3. To understand the behavior of properties at different low temperatures.

COURSE CONTENT

Basics of thermodynamic processes, introduction to refrigeration, air conditioning and cryogenics.


Cryogenic fluids, properties, behavior of cryogenics fluids, storage of cryogenic fluids, Properties of materials at cryogenic temperatures, Insulation techniques, different types, vacuum techniques.
REFERENCE BOOKS:

1. Arora, R.C., Refrigeration and Air Conditioning, PHI Pvt Ltd, 2010

COURSE OUTCOMES

1. Explain and apply the concepts of refrigeration, air conditioning and cryogenics.
2. Understand the properties of materials at low temperatures
3. Apply different insulation and vacuum techniques for low temperature systems.

MEOE21 – WASTE TO ENERGY CONVERSION TECHNIQUES

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<th>Course Code:</th>
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<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Waste to Energy Conversion Techniques</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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COURSE LEARNING OBJECTIVES

1. The course focuses on bio-Energy and in particular on the exploitation of biomass.
2. To study about the thermochemical Conversion processes (gasification, pyrolysis)
3. To distinguish the factors influencing biofuels/energy-related environmental, economics, & social issues.
4. To study about the impacts of biofuel utilization and application and LCA assessment on biofuel Production.

COURSE CONTENT:

Introduction to energy from waste- Chemical composition, properties of biomass – Energy plantations, Size reduction, Briquetting, Drying, Storage and handling of biomass.


Biochemical conversion of biomass to alcohol, Biodiesel production from oilseeds, waste oils and algae, Fischer tropsch synthesis, gas to liquid conversion technologies.

Combustion of biomass and cogeneration systems, combustion of woody biomass, theory calculation and design of equipment, fuel cell, gas turbine, Electricity generation, case studies.

REFERENCE BOOKS:


COURSE OUTCOME:

At the end of the course, students will be able to understand
1. Characterization techniques of the biomass and Effective utilization of biomass from Wastes
2. Practical knowledge in the Thermochemical conversion techniques.
3. Power generation from bioenergy and the applications.
4. Techno-economic analysis of thermochemical conversion and LCA assessment

MEOE22 – NON-DESTRUCTIVE TESTING

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<tr>
<td>Course Name:</td>
<td>Non-Destructive Testing</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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COURSE LEARNING OBJECTIVES

1. To understand the basic principles, testing procedures and limitations of various NDT methods.
2. To study the codes, standards or specifications related to each testing method.
3. To identify the types of equipment used for each non-destructive examination for various industrial applications.

COURSE CONTENT

Overview of NDT: Introduction to destructive and non-destructive testing, Significance of testing materials, properties of engineering materials. Scope, characteristics and Limitations of NDT, Visual examination methods – Different visual examination aids.


Applications in Engineering Industry: Dimensional Measurement, Estimation of Mechanical and Physical properties of materials, Analysis of quality of weldments, Leak and pressure testing of pressure vessels.

COURSE OUTCOME

1. Be able to select appropriate NDT methods for flaw detection.
2. Be able to use the various Testing methods for understanding the defects and characterization of industrial components.
3. Be able to perform non-destructive examinations of weldments.
4. Acquire the knowledge to identify strengths and weaknesses in materials used in fabrication.

REFERENCE BOOKS


MEOE23 – POLLUTION AND CONTROL

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<th>Course Code:</th>
<th>MEOE23</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Pollution and Control</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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COURSE LEARNING OBJECTIVES

1. To impart knowledge on the atmosphere and eco-legislations
2. To classify air, water and land pollutants and sources
3. To understand hazardous waste management
4. To learn pollution sampling and analysis
5. To study the various methods of controlling pollution
COURSE CONTENT


Clean technologies - Integrated design for pollution prevention and control - case studies - Legal control of pollution – trends and issues.

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will be able to

1. Understand the atmospheric pollutants and eco-legislations
2. Classify air, water and land pollutants and sources
3. Manage hazardous wastes in industries
4. Measure and Analyse various pollutants
5. Understand various methods of controlling pollution
COURSE LEARNING OBJECTIVES

To study the different types of welding process and its application in various fields

COURSE CONTENT

Classification of welding processes: heat sources. Weld joint design - Weldability of steels and other materials - Weld defects.

TIG / A-TIG Welding, gas metal arc welding, Submerged arc welding, Friction welding, Explosive welding, Plasma arc welding

Electron beam welding, Laser beam welding - advantages and limitations, process variables and their effects,

Friction welding process - effects of speed and pressure –Types- Explosive welding –Process Parameters-Plasma arc welding

Cold pressure welding - Ultrasonic welding - Recent Advances in welding - Modeling and optimization of welding process.

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will be able to get the knowledge about newly developed welding process and its parameters
V. MINOR (MI) COURSES

MEMI10 – BASICS THERMODYNAMICS

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<tr>
<td>Course Name:</td>
<td>Basics Thermodynamics</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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COURSE LEARNING OBJECTIVES

1. To achieve an understanding of principles of thermodynamics and to be able to use it in accounting for the bulk behavior of the simple physical systems.
2. To provide in-depth study of thermodynamic principles, thermodynamics of state, basic thermodynamic relations, Principle of psychrometry & properties of pure substances
3. To enlighten the basic concepts of vapor power cycles.

COURSE CONTENT

Concept of continuum - thermodynamic systems. Property - state - path and process, quasi-static process, work - types of work, Zeroth law of thermodynamics, First law applied to control mass, control volumes. Steady flow energy equation - applications of SFEE


Gas mixtures – properties ideal and real gases, equation state, Avogadro's Law, Vander Waal's equation of state, compressibility factor, compressibility chart – Dalton’s law of partial pressure, exact differentials, Maxwell’s relations, Clausius Clapeyron equations, Joule–Thomson coefficient.


REFERENCE BOOKS:

COURSE OUTCOMES

At the end of the course student will

1. Analyze any engineering problem based on the basic concepts and logical sequences
2. Define the fundamental laws of thermodynamics and explain their application to a wide range of systems.
3. Analyze the work and heat interactions associated with a prescribed process path and to perform analysis of a flow system.
4. Apply the principle of efficient operation on energy utilization and value its impact on the personal and national economy
5. Evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.

MEMI11 – FUNDAMENTALS OF THERMAL ENGINEERING

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<th>No. of Credits:</th>
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<tr>
<td>Course Name:</td>
<td>Fundamentals of Thermal Engineering</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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COURSE LEARNING OBJECTIVES

1. To integrate the concepts, laws and methodologies from the first course in thermo dynamics into analysis of cyclic processes
2. To apply the thermodynamic concepts into various thermal application like IC engines, Steam Turbines, Compressors and Refrigeration and Air conditioning systems

COURSE CONTENT

Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure, and air standard efficiency

Classification - Components and their function - Valve timing diagram and port timing diagram - Comparison of two stroke and four stroke engines - Carburettor system, Diesel pump and injector system.

Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, supersaturated flow, Impulse and Reaction principles, compounding, speed regulations – Governors.

Classification and working principle of various types of compressors, work of compression, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency, multistage air compressor and inter cooling

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will

1. Define the basic concepts of units and dimensions, systems (open and closed systems and control volumes) and its boundaries, properties, state, process, cycle, quasi-static process etc.-required as foundation for development of principles and laws of thermodynamics
2. Develop Intuitive problem solving technique
3. Use & Practice two property rule and hence thermodynamic tables, thermodynamic diagrams and concept of equation of state, also their simple application.
4. Explain heat, work and first law of thermodynamics. Application of energy balance

MEMI12 – FLUID MECHANICS AND MACHINERY

<table>
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<th>Course Code:</th>
<th>MEMI12</th>
<th>No. of Credits:</th>
<th>03</th>
</tr>
</thead>
</table>
| Course Name: | Fluid Mechanics and Machinery | Prerequisite: | -Nil-

COURSE LEARNING OBJECTIVES

1. The student is introduced to the mechanics of fluids through a thorough understanding of the properties of fluids.
2. The dynamics of fluids is introduced through the control volume approach which gives an integrated understanding of the transport of mass, momentum and energy.
3. The student is introduced with various types of hydraulic machines and its performance.

COURSE CONTENT


Types of Fluid Flow - one dimensional continuity, momentum and Energy equations-Flow measurement - Orificemeter - Venturimeter, Pitot tube, orifices, mouthpieces, notches and weirs
Laminar and turbulent flows - Flow through pipes - Dimensional and Model analysis. Boundary layer concepts.


Turbines - Hydraulic turbines - types - specific speed - Pelton - Francis and Kaplan turbines - Calculation of power output efficiencies.

REFERENCE BOOKS


COURSE OUTCOMES

At the end of the course student will
1. Understand the properties of fluids and basic principles of fluid mechanics
2. Ability to analyze the fluid flow problems with the application of the mass, momentum and energy equations.
3. Determine flow through hydraulics machines and pipes

MEMI13 – FUNDAMENTALS OF HEAT AND MASS TRANSFER

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<th>Course Code:</th>
<th>MEMI13</th>
<th>No. of Credits:</th>
<th>03</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Fundamentals of Heat and Mass Transfer</td>
<td>Prerequisite:</td>
<td>-Nil-</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To learn various modes of heat transfer and understand the basic concepts of mass transfer.
2. To understand the applications of various experimental heat transfer correlations in engineering applications.
3. To discuss the thermal analysis and sizing of heat exchangers.
COURSE CONTENT


Boiling and condensation – pool boiling regimes and correlations – critical heat flux flow boiling – correlations- Nusselt's theory

Heat exchangers - Fouling factor, LMTD and NTU methods - Mass transfer - Fick’s law - analogy between heat and mass transfer

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will
1. Explain about the real time applications of heat transfer in both solids and fluids.
2. Describe the fundamentals of natural and forced convective heat transfer process.
3. Design the heat exchange equipment.
4. Explore the real time applications of radiation mode of heat transfer.
5. Relate the mass transfer concepts for various industrial applications.
MEMI15 – FUNDAMENTALS OF AUTOMOTIVE TECHNOLOGY

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<th>Course Code:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Fundamentals of Automotive Technology</td>
<td>Prerequisite:</td>
<td>-Nil-</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To understand the construction and working principle of various parts of an automobile.
2. To have the practice for assembling and dismantling of engine parts and transmission system

COURSE CONTENT

Types of automobiles, vehicle construction and different layouts, chassis, frame and body

Electronically controlled gasoline injection system for SI engines, electronically controlled diesel injection system, Electronic ignition system, Turbo chargers, Catalytic converter

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, over drive, transfer box, fluid flywheel –torque converter, propeller shaft, slip joints, universal joints

Steering geometry and types, types of Front Axle, Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System and Traction Control

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternative fuels. EV and Hybrid vehicles

REFERENCE BOOKS:

COURSE OUTCOMES

At the end of the course student will
1. To develop electronically modified injection systems
2. Identify the use of fuels and its emission characteristics
3. To perform both hydraulic and pneumatic braking systems
4. To identify the type of transmission of motion in vehicles

MEMI17 – FUNDAMENTALS OF REFRIGERATION AND AIR CONDITIONING

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<th>MEMI17</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Fundamentals of Refrigeration and Air Conditioning</td>
<td>Prerequisite:</td>
<td>-Nil-</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To understand the principles of refrigeration and air conditioning.
2. To design and implement refrigeration and air conditioning systems using standards.

COURSE CONTENT

Introduction about Refrigeration – Definitions of various terms.


Analysis of Vapour compression cycle, Modifications to basic cycle

Psychrometry – Definitions for properties. Introduction to cooling load calculations

Air-conditioning systems – discussion about the central plant with direct evaporator and chiller applications, Ice plant, refrigerators.

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will
1. Illustrate the basic concepts of refrigeration system.
2. Explain the components of vapour compression system.
3. Demonstrate the use of psychrometry in analyzing refrigeration systems.
4. Discuss the theory and concept of air-conditioning systems.

**MEM18 – PRINCIPLES OF TURBOMACHINERY**

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<tr>
<td>Course Name:</td>
<td>Principles of Turbomachinery</td>
<td>Prerequisite:</td>
<td>-Nil-</td>
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</table>

**COURSE LEARNING OBJECTIVES**

1. To understand the operating principles of various turbomachines and analyse their use for various engineering applications.

**COURSE CONTENT:**

Classification of Turbomachines. Energy transfer between fluid and rotor - Euler equation and its interpretation.

Velocity triangles. Thermal, Mechanical and overall efficiencies. Polytropic efficiency. Degree of reaction.

Dimensionless parameters for Turbomachines.

Centrifugal Fans and Blowers

Centrifugal and Axial Flow Compressors

Axial and Radial Flow Turbines

**REFERENCE BOOKS:**


**COURSE OUTCOME**

At the end of the course student will able to explain the various systems, principles and applications and different types of turbo machinery components
MEMI19 – FUNDAMENTALS OF INTERNAL COMBUSTION ENGINES

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<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Fundamentals of Internal Combustion Engines</td>
<td>Prerequisite:</td>
<td>-Nil-</td>
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COURSE LEARNING OBJECTIVES

1. To understand the underlying principles of operation in different IC Engines and components.
2. To provide knowledge on pollutant formation, control, alternate fuel etc.

COURSE CONTENT


Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, NOx, Smoke and Particulate matter – Methods of controlling Emissions

Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel


REFERENCE BOOKS:


COURSE OUTCOME:

At the end of the course student will impart the fundamental knowledge of Internal Combustion Engines
COURSE LEARNING OBJECTIVES

1. To create an awareness on the various environmental pollution aspects and issues.
2. To give a comprehensive insight into the pollution in engine and gas turbines.
3. To impart knowledge on pollutant formation and control.
4. To impart knowledge on various emission instruments and techniques.

COURSE CONTENT

Atmospheric pollution from Automotive and Stationary engines and gas turbines, Global warming–Greenhouse effect and effects of I.C. Engine pollution on environment. 100


Non dispersive infrared gas analyzer, gas chromatography, chemiluminescent analyzer and flame ionization detector, smoke meters – Noise measurement and control

Engine Design modifications, fuel modification, evaporative emission control, EGR, air injection, thermal reactors, Water Injection, catalytic converters, application of microprocessor in emission control. Common rail injection system, Particulate traps, NOx converters, SCR systems. GDI and HCCI concepts

Transient dynamometer, Test cells, Driving cycles for emission measurement, chassis dynamometer, CVS system, National and International emission standards

REFERENCE BOOKS:

COURSE OUTCOME

At the end of the course student will
1. Learn about pollution formation in engines, and its control
2. The ways and means to protect the environment from various types of pollution

MEMI22 – DYNAMICS

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<tbody>
<tr>
<td>Course Name:</td>
<td>Dynamics</td>
<td>Prerequisite:</td>
<td>-Nil-</td>
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COURSE LEARNING OBJECTIVES

By the end of the course, you should be able to do the following:
1. Create mathematical models of dynamic systems (point mass and rigid bodies)
2. Analyze the kinematics of point mass and rigid body systems.
3. Determine the motion of point mass and rigid body systems in space and time.
4. Use engineering software tools such as Mathcad or Mathematica to solve problems of point mass and rigid body systems kinematics and dynamics

COURSE CONTENT

Rectilinear Translation

Curvilinear Translation
Kinematics of curvilinear motion-Differential equations of curvilinear motion-Motion of a projectile-D'Alembert's principle in curvilinear motion-Moment of momentum-Work and energy in curvilinear motion.

Rotation of a Rigid Body about a Fixed Axis
Kinematics of rotation-Equation of motion for a rigid body rotating about a fixed axis-Rotation under the action of a constant moment-Torsional vibration-The compound pendulum-General case of moment proportional to angle of rotation-D'Alembert's principle in rotation-Resultant inertia force in rotation-The principle of angular momentum in rotation -Energy equation for rotating bodies-Gyroscopes.

Plane Motion of a Rigid Body
Kinematics of plane motion-Instantaneous center-Equations of plane motion-D'Alembert's principle in plane motion-The principle of angular momentum in plane motion-Energy equation for plane motion.
Department of Mechanical Engineering, National Institute of Technology, Tiruchirappalli

Relative Motion
Kinematics of relative motion-Equations of relative motion- D’ Alembert's principle in relative motion.

REFERENCE BOOKS:


COURSE OUTCOMES

1. Developed a clear understanding of the basic principles that govern the dynamics of particles and rigid bodies and
2. The ability to apply the knowledge and tools to solve engineering problems

MEMI23 – FUNDAMENTALS OF MECHANICAL DESIGN

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<tr>
<td>Course Name:</td>
<td>Fundamentals of Mechanical Design</td>
<td>Prerequisite:</td>
<td>-Nil-</td>
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</table>

COURSE LEARNING OBJECTIVES

1. Intended to provide an introduction to the design process.
2. Impart the Fundamental information on materials in selecting the most appropriate materials, processes and methods to transform his ideas into a successful product.
3. To understand the effect of various loads and corresponding deformation and stresses in mechanical components.
4. To learn the procedure to design various mechanical components such as shafts, springs, bearing etc.,

COURSE CONTENT


Load and Stress Analysis – Equilibrium and Free-body diagrams, Shear force and Bending moments in beams, Stress and Strains, Deflection and Stiffness – Spring rates, Tension, Compression and Torsion, Deflection due to bending, Strain Energy.

Failures resulting from Static Loading – Static Strength, Stress Concentration, Failure theories.

Design of Mechanical Elements – Shaft and Shaft Components, Screws, Fasteners, Springs – Helical and leaf springs, Rolling contact bearings, Gears – Spur and Helical gears.
REFERENCE BOOKS:


COURSE OUTCOMES

After the successful completion of this course, a student can
1. Describe the design process, material selection, calculation of stresses and stress concentrations under static loading.
2. Differentiate various modes of failures in mechanical components.
3. Design the basic mechanical components like shafts, fasteners, Springs and Bearings
4. Summarize the knowledge in Gears, Types of gears and its applications.
5. Select an appropriate machine element for suitable applications.
VI. HONORS (HO) COURSES

MEHO10 – ADVANCED HEAT TRANSFER

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<th>Course Code:</th>
<th>MEHO10</th>
<th>No. of Credits:</th>
<th>04</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Advanced Heat Transfer</td>
<td>Prerequisite:</td>
<td>MEPC19</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To use Heisler and Grober charts and to discuss about transient heat conduction
2. To compare and optimize longitudinal fin of rectangular, triangular and parabolic profiles
3. To understand boundary layers and to formulate pool and flow boiling correlations
4. To discuss thermal radiation, view factor, gas radiation and the effect of radiation on temperature measurement.

COURSE CONTENT


Extended surfaces – Steady state analysis and optimization – Longitudinal fin of rectangular, triangular and parabolic profile radiating to free space – Radial fins.

Thermal boundary layers – Momentum and energy equations – Internal and external flows – Forced convection over cylinders, spheres and bank of tubes, turbulent convection.

Heat transfer with phase change – Condensation and boiling heat transfer – Heat transfer in condensation, Condensation outside and inside horizontal tubes, Effect of non-condensable gases in condensing equipment – Pool and flow boiling correlations. Flow regimes in two phase flow – Dryout phenomenon – Heat Transfer at Supercritical pressure


REFERENCE BOOKS

MEHO11 – ADVANCED FLUID MECHANICS

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<tr>
<th>Course Code:</th>
<th>MEHO11</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Advanced Fluid Mechanics</td>
<td>Prerequisite:</td>
<td>MEPC14</td>
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</table>

COURSE LEARNING OBJECTIVES

1. To familiarize with the fundamental concepts of fluid dynamics.
2. To formulate and analyze problems related to exact solutions of N-S equations
3. To approximate N-S equations and solve them for special cases
4. To differentiate between stable and unstable flows
5. To analyze and apply models of turbulence

COURSE CONTENT

Review of Basic concepts- Reynold’s transport theorem, Body and surface forces, stress tensor. Scalar and vector fields, Eulerian and Lagrangian description of flow. Motion of fluid element; translation, rotation and vorticity; strain rate tensor, continuity equation, stream function and velocity potential. Constitutive equations, derivation of Navier-Stokes equations, sign of dynamic viscosity.

Exact solutions of Navier-Stokes equations: plane Poiseuille flow and Couette flow, Hagen-Poiseuille flow, flow between two concentric rotating cylinders, Stokes first and second problems, Hiemenz flow, flow near a rotating disk, flow in convergent-divergent channels.


REFERENCE BOOKS:

4. A first course in turbulence, Tennekesse and Lumley
5. Fluid mechanics, Kundu and Cohen
6. An Introduction to Fluid Dynamics, G K Bachelor

COURSE OUTCOMES

At the end of the course student will

1. Identify and obtain the values of fluid properties and relationship between them and understand the principles of continuity, momentum, and energy as applied to fluid motions.
2. Recognize these principles written in form of mathematical equations.
3. Solve the N-S equations to obtain solutions for varied types of flows.

MEHO12 – SIMULATION OF IC ENGINES

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<th>Course Code:</th>
<th>MEHO12</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Simulation of IC Engines</td>
<td>Prerequisite:</td>
<td>MEPC17</td>
</tr>
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</table>

COURSE LEARNING OBJECTIVES

1. Calculate basic engine parameters of significance for the operation of an engine and the effect of varying them on performance and fuel economy.
2. Simulate engine operation through the use of ideal air cycle models, ideal air exchange models, fuel air processes with chemical equilibrium and time dependent models that include heat transfer and time dependent combustion.
3. Use simple models to describe the combustion processes in spark ignition and diesel engines
4. Evaluate the effect of the air exchange process on engine performance, fuel economy and other basic engine characteristics for 4-stroke engines

COURSE CONTENT

First and second laws of thermodynamics – Estimation of properties of gas mixtures - Structure of engine models – Open and closed cycle models - Cycle studies


**REFERENCE BOOKS:**


**COURSE OUTCOMES**

At the end of the course student will

1. Conversant with Basic Concept of Modeling
2. To develop modeling of IC engines.
3. To develop of Laminar Flow modeling
4. Understands Simulation of IC Engines and its new concepts
COURSE LEARNING OBJECTIVES

1. Provide students with opportunities to apply basic flow equations;
2. How to compare and chose machines for various operations.

COURSE CONTENT


Centrifugal compressor - configuration and working – slip factor - work input factor – ideal and actual work - pressure coefficient - pressure ratio. Axial flow compressor – geometry and working – velocity diagrams – ideal and actual work – stage pressure ratio - free vortex theory – performance curves and losses


Gas turbine cycle analysis – simple and actual. Reheated, Regenerative and Intercooled cycles for power plants. Working of Turbojet, Turbofan, Turboprop, Ramjet, Scramjet and Pulsejet Engines and cycle analysis – thrust, specific impulse, and specific fuel consumption, thermal and propulsive efficiencies.

REFERENCE BOOKS:

Department of Mechanical Engineering, National Institute of Technology, Tiruchirappalli


COURSE OUTCOMES

At the end of the course student will
1. Explain basic concepts of turbomachines and visualize dimensional analysis.
2. Describe the working of Pelton, Francis and Kaplan along their performance parameters.
3. Discuss the operation of centrifugal pumps, centrifugal and axial compressors.
4. Associate the effect of cavitation in turbines and pumps.
5. Express the basic cycles and calculations involved in the operation of steam and gas turbines.

MEHO14 – ADVANCED ENGINEERING MATERIALS

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<th>Course Code:</th>
<th>MEHO14</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>ADVANCED ENGINEERING MATERIALS</td>
<td>Prerequisite:</td>
<td>MEPC18</td>
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</table>

COURSE LEARNING OBJECTIVES

1. Distinguish various classes of advanced materials, their processing, properties and applications
2. Interpret new terms and information on ultra-light materials, Biomaterials, coatings and thin films, composites, and high temperature refractory materials for aerospace applications.
3. Distinguish materials suitable for application at elevated temperatures and identify coatings suitable for protection applications
4. Introduction and application of Smart materials and meta-materials.

COURSE CONTENT

Ultralight materials and metallic foams, material definition and processing, characterization of cellular metals, material properties

Composite materials, classifications, properties and applications.


Smart Materials: Stimuli responsive materials, Light actuators, Heat actuators, etc.

Multi-scale modelling: Introduction to Microscale (Molecular dynamics), Meso-Scale, Macroscale (continuum) modelling methods of materials.

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will
1. Some understanding of types, manufacturing processes, and applications of advanced materials
2. A recognition of the need for and an ability to engage in life-long learning and knowledge of contemporary issues
3. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

MEHO15 – DESIGN OF HEAT EXCHANGERS

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<th>MEHO15</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Design of Heat Exchangers</td>
<td>Prerequisite:</td>
<td>MEPC19</td>
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COURSE LEARNING OBJECTIVES

1. To learn the thermal and stress analysis on various parts of the heat exchangers
2. To analyze the sizing and rating of the heat exchangers for various applications

COURSE CONTENT

Types of heat exchangers, shell and tube heat exchangers – regenerators and recuperators
Temperature distribution and its implications - Parts description, Classification as per Tubular Exchanger Manufacturers Association (TEMA)


Types- Merits and Demerits- Design of compact heat exchangers, plate heat exchangers, performance influencing parameters, limitations. Polymer heat exchangers
Design of surface and evaporative condensers, Shell and Tube condensers - condensers for low temperature applications, design correlations for condensers – cooling tower – performance characteristics

Cryogenic heat exchangers – Tubular heat exchangers, matrix heat exchangers, coiled tube heat exchangers, Giaque Hampson heat exchangers.

REFERENCE BOOKS:


COURSE OUTCOME

At the end of the course student will apply the mathematical knowledge for thermal and stress analysis on various parts of the heat exchangers components

MEHO16 – DESIGN AND OPTIMIZATION OF THERMAL ENERGY SYSTEMS

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<th>MEHO16</th>
<th>No. of Credits:</th>
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<tbody>
<tr>
<td>Course Name:</td>
<td>Design and Optimization of Thermal Energy Systems</td>
<td>Prerequisite:</td>
<td>MEPC17</td>
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COURSE LEARNING OBJECTIVES

1. To learn basic principles underlying piping, pumping, heat exchangers; modeling and optimization in design of thermal systems.
2. To develop representational modes of real processes and systems.
3. To optimization concerning design of thermal systems.
COURSE CONTENT

Introduction to Energy System Design - Regression analysis and Equation fitting

Modeling of thermal equipment - heat exchangers, evaporators, condensers, turbomachines, distillation equipment. Absorber, generator, GAX.

System simulation - Application of successive method and Newton Raphson Method to Energy Systems


Cost analysis by present worth-annual cost-Evaluating potential Investments-Forecasting Techniques-

Economic Factors in Energy Systems-Examples


REFERENCE BOOKS:


COURSE OUTCOME:

At the end of the course student will learn the modelling and optimization of thermal system with various equipment like piping, heat exchangers and pumping.
COURSE LEARNING OBJECTIVES:

1. To discuss the types of heat transfer equipment and various flow patterns.
2. To study shell and tube heat exchanger and other types of heat exchangers for special services.
3. To understand the design procedure of air pre-heaters, economizers, super heaters, condensers and cooling towers for thermal power plants.
4. To design plate and compact heat exchangers for industrial applications.

COURSE CONTENT:

Classification of heat transfer equipment - Design of shell and tube heat exchanger - Finned surface heat exchanger – Heat exchangers for special services – Fired heaters

Plate and spiral plate heat exchanger – plate heat exchanger for Dairy industry – Heat Pipes

Thermal design of heat exchange equipments such as Air pre-heaters, Economizer – Super heater and condensers.

Selection of compact heat exchangers. Analysis and design of cooling towers.

REFERENCE BOOKS:

COURSE OUTCOME:

At the end of the course student will be able to
1. Classify the various heat transfer equipment
2. Design various heat exchangers viz. shell and tube, finned surface & special purposes for thermal engineering industries.
3. Analyze the performance of air pre-heaters, economizers, super heaters and condensers for power plants.
4. Design compact heat exchangers and cooling towers.
5. Select a suitable heat exchanger for any given application.

MEHO18 – ANALYSIS AND DESIGN OF PRESSURE VESSELS

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<th>No. of Credits:</th>
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<tr>
<td>Course Name:</td>
<td>Analysis and Design of Pressure Vessels</td>
<td>Prerequisite:</td>
<td>MEPC12</td>
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COURSE LEARNING OBJECTIVES:

1. To impart basic knowledge of design of pressure vessels and piping system.
2. To introduce use of various standards used for the pressure vessel design.
3. To analyze the general applications of pressure vessels
4. To understand the development of cracks, fracture mechanism and corrosion
5. To perform finite element analysis on high pressure and temperature components

COURSE CONTENT:

Establishment of design conditions – Fracture Mechanics – Heads, Basic shell thickness - Reinforcement of openings – Special components like flange, tube plate, supports.


Application of general analysis – Flat closure plates –conical heads and reducers – hemispherical and torispherical, ellipsoidal heads.

Development of cracks - Fracture mechanics - Corrosion - Selection of working stress for ductile and brittle materials.

Finite element analysis for high pressure and high temperature components.
REFERENCE BOOKS:


COURSE OUTCOME:

At the end of the course student will be able to

1. Analyze thin plates and shells for various types of stresses.
2. Design shells, end closures and nozzles of pressure vessels using ASME codes.
3. Analyze the general applications of pressure vessel
4. Understand the fracture and corrosion mechanism
5. Analyze the FEM models on high pressure and temperature components

MEHO19 – ANALYSIS OF THERMAL POWER CYCLES

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<tbody>
<tr>
<td>Course Name:</td>
<td>Analysis of Thermal Power Cycles</td>
<td>Prerequisite:</td>
<td>MEPC17</td>
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</table>

COURSE LEARNING OBJECTIVES:

1. To describe sources of energy and types of power plants.
2. To analyze different types of steam cycles and estimate efficiencies in a steam power plant.
3. To define the performance characteristics and components of power plants.
4. To study and analyze various refrigeration cycles

COURSE CONTENT:

Steam power plant cycle - Rankine cycle - Reheat cycle - Regenerative cycle with one and more feed heaters - Types of feed heaters - Open and closed types - Steam traps types.

Cogeneration - Condensing turbines - Combined heat and power - Combined cycles - Brayton cycle Rankine cycle combinations - Binary vapour cycle.

Air standard cycles - Cycles with variable specific heat - fuel air cycle - Deviation from actual cycle.

Brayton cycle - Open cycle gas turbine - Closed cycle gas turbine - Regeneration - Inter cooling and reheating between stages.

Refrigeration Cycles - Vapour compression cycles - Cascade system - Vapour absorption cycles - GAX Cycle.
REFERENCE BOOKS:


COURSE OUTCOME:

At the end of the course student will be able to

1. Understand various energy resources and conversion methods and equipments
2. Derive efficiency calculation for various power cycles.
3. Understand different refrigeration cycles.

MEHO20 – FUELS COMBUSTION AND EMISSION CONTROL

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<th>Course Code:</th>
<th>MEHO20</th>
<th>No. of Credits:</th>
<th>04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Name:</td>
<td>Fuels Combustion and Emission Control</td>
<td>Prerequisite:</td>
<td>MEPC17</td>
</tr>
</tbody>
</table>

COURSE LEARNING OBJECTIVES:

1. To study fuels and their properties combustion chemistry and stoichiometry.
2. To solve simplified conservation equations for reacting flows and to compare different types of FBCs.
3. To distinguish the factors influencing flame velocity and thickness flame stabilization.
4. To understand the emission norms and standards

COURSE CONTENT:


Chemical kinetics - Important chemical mechanisms - Simplified conservation equations for reacting flows - Laminar premixed flames - Simplified analysis.

Factors influencing flame velocity and thickness flame stabilization - Diffusion flames - Introduction to turbulent flames.

Coal combustion systems – Liquid fuel atomizers - FBC - Different types of FBCs - Models for droplet and Carbon particle combustion.

Emissions - Emission index - Corrected concentrations - Control of emissions for premixed and non-premixed combustion.
Fuel chemical kinetic simulations with detailed and reduced reaction mechanism – Numerical simulation of simplified combustion problems using CFD package

REFERENCE BOOKS:


At the end of the course student will be able to

1. Recall fuels and their properties combustion chemistry and stoichiometry.
2. Construct simplified conservation equations for reacting flows.
3. Choose the factors influencing flame velocity and thickness flame stabilization.
4. Discuss emissions, emission index and control of emissions for premixed and no premixed combustion.

MEHO21 – FINITE ELEMENT METHOD IN MECHANICAL ENGINEERING

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<th>Course Code:</th>
<th>MEHO21</th>
<th>No. of Credits:</th>
<th>04</th>
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</thead>
<tbody>
<tr>
<td>Course Name:</td>
<td>Finite Element Method in Mechanical Engineering</td>
<td>Prerequisite:</td>
<td>MEPC19</td>
</tr>
</tbody>
</table>

1. To Understand the concepts behind variational methods and weighted residual methods in FEM.
2. To Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements.
3. To learn the theory and characteristics of finite elements that represent engineering structures.
4. To apply Suitable boundary conditions to a global structural equation, and reduce it to a solvable form.
5. To identify how the finite element method expands beyond the structural domain, for problems involving heat transfer and vibrational analysis.

COURSE CONTENT:

Introduction, Weighted Residual Methods, Shape functions, Coordinate systems, Numerical Integration.
Integral Formulation for Numerical Solutions, Coordinate systems, Galerkin’s Approach for one dimensional and two-dimensional problems

Potential Energy Formulations – Axial Force Member, Truss, Beam and Plane frame elements.

Plane stress, plane strain and axisymmetric problems. Isoparametric elements and Lagrangian interpolation polynomial.

Finite Element Analysis in Steady State and Transient problems. Solution Techniques to Vibrational analysis

**Laboratory Experiments**

1. Basic problems in Structural Mechanics and Heat Transfer Analysis using Finite element codes
2. 1D, 2D and 3D field problems
3. Conduction and Convection based problems
4. Transient analysis
5. Vibration analysis

**REFERENCE BOOKS:**


**COURSE OUTCOMES**

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

1. Understand the concepts behind variational methods and weighted residual methods in FEM.
2. Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3-D element.
3. Develop element characteristic equation procedure and generation of global stiffness equation will be applied.
4. Apply Suitable boundary conditions to a global structural equation, and reduce it to a solvable form.
5. Identify how the finite element method expands beyond the structural domain, for problems involving heat transfer and vibrational analysis.
MEHO22 – SMART MATERIALS AND STRUCTURES

Course Code: MEHO22  
No. of Credits: 04
Course Name: Smart Materials and Structures  
Prerequisite: MEPC13

COURSE LEARNING OBJECTIVES:

1. To understand the interdisciplinary material properties for sensors and actuators applications.
2. To familiarize the working principles of various sensors for different applications.
3. To describe the role of actuators and actuator materials.
4. To introduce the basic concepts of piezoelectric energy harvesting.
5. To discuss the various measurements and signal processing techniques for structural dynamic applications.

COURSE CONTENT


Introduction to Piezoelectric Energy harvesting - Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modelling - piezoelectric generators, Piezoelectric energy harvesting applications.

Measurement and Signal Processing Techniques – Static and Dynamic Measurement Methods- Signal conditioning devices; Structural dynamics and Identification techniques; Passive, Semi -active and Active control; Feedback and feed forward/control strategies.

REFERENCE BOOKS:


COURSE OUTCOMES

At the end of the course student will be able to
1. Make use of various smart materials properties for sensors and actuators applications.
2. Apply the working principles of sensors for various applications.
3. Identify the suitable actuators for corresponding applications.
4. Model the piezoelectric effect for energy harvesting.
5. Demonstrate the measurement and signal processing techniques for structural dynamics testing.

MEHO23 – FUNDAMENTALS OF BIOMECHANICS

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<th>Course Code:</th>
<th>MEHO23</th>
<th>No. of Credits:</th>
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</thead>
<tbody>
<tr>
<td>Course Name:</td>
<td>Fundamentals of Biomechanics</td>
<td>Prerequisite:</td>
<td>MEPC10</td>
</tr>
</tbody>
</table>

COURSE LEARNING OBJECTIVES:

1. To study the biomechanical concepts in living systems.
2. To describe the biological, mechanical, and neurological mechanisms by which muscles produce movement.
3. To write and solve equations of motion for simple models of human movement.

COURSE CONTENT

Introduction to Biomechanics- Review of the principles of mechanics, Vector mechanics, biomechanics, anatomical terminology, Anthropometry, motion in the human machine.

Biomechanics of Joints- Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle, Introduction to bio fluid Mechanics, Rheological properties of blood, laminar flow, couette flow and Hagen poiseuille equation, turbulent flow.

Cardiovascular and Respiratory Mechanics – Cardiovascular system, artificial heart valves, biological and mechanical valves development, testing of valves, Blood Flow Models, Blood Vessel Mechanics, Heart valve dynamics, prosthetic valve dynamics. Mechanism of air flow, respiratory cycle, lung ventilation model, methods of determining pressure, flow rate and volume spirometry.

Applied Biomechanics and Biomechanics of Implants- Engineering approaches to standing, sitting and lying. Biomechanics of gait, application of gait and locomotion analysis, Fluid mechanics and energetics: Forms of energy and energy transfer, Design of orthopedic implant, specifications for a prosthetic joint, biocompatibility, requirement of a biomaterial, characteristics of different types of biomaterials, manufacturing process of implants, fixation of implants.

REFERENCE BOOKS:


COURSE OUTCOMES:

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

1. Understand the biomechanics principles and gait analysis of human locomotion
2. Derive the joint force and muscle force for various biomechanical systems in the human body.
3. Explain the application of basic mechanical principles in human motion.

MEHO24 – COMPUTATIONAL METHODS IN ENGINEERING

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<th>MEHO24</th>
<th>No. of Credits:</th>
<th>04</th>
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</thead>
<tbody>
<tr>
<td>Course Name:</td>
<td>Computational Methods in Engineering</td>
<td>Prerequisite:</td>
<td>-NIL-</td>
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</tbody>
</table>

COURSE LEARNING OBJECTIVES

1. To provide an introduction to the numerical methods to solve various kinds of equations that students encounter in the field of engineering.
2. Numerical methods for solving ODEs and PDEs
3. Students able to develop his/her own programs/subroutines for the numerical schemes taught in the course.
COURSE CONTENT

Introduction: Numerical precision in digital computing and its effect on numerical calculations, Taylor series and truncation, Rounding off errors, Introduction to programming

System of Equations and Eigen values: Review of solution methods to system of linear equations, Computation of Eigen values, solution of algebraic equations (univariate and multivariate non-linear equations, root finding and optimization), Well-conditioned and ill conditioned system, Matrix and vector norms,

Interpolation, differentiation and integration: Interpolation (polynomial, Lagrange interpolation, error estimates, piecewise polynomial, Hermite, Spline, 2D (rectangle and triangle)), Curve Fitting/Regression, Numerical Differentiation, Numerical Integration (Simpson’s rule, Guass Quadrature)

Ordinary Differential Equations: Initial value problems (Euler Method, RK methods, Predictor corrector methods), Boundary Value Problems (Shooting method, FDM, FEM, Weighted residuals, FVM).

Partial Differential Equations - Introduction to PDEs, classification of PDEs, Numerical solutions methods, Laplace and Poisson Equations, Iterative methods (Jacobi, Guass-Seidal, steepest decent and conjugate gradient)

Laboratory: Coding the above iterative methods in MATLAB/C++/Fortran

REFERENCE BOOKS:

1. S. P. Venkateshan, Prasanna Swaminathan, Computational Methods in Engineering, Ane Books
2. Steven C. Chapra, Numerical Methods for Engineering, Mc-Graw Hill Education

COURSE OUTCOMES

On completion of course students should be able to

1. Numerically compute solution of system of equations through programing
2. Compute numerical solution for ODE and PDE using coding
3. Evaluate various iterative methods using computer programming.
4. Perform curve fitting and regression analysis
5. Solve BVP and IVP numerically
VII. ONLINE COURSES

The online NPTEL courses offered are dynamic and change with time, Hence, the students can opt for online courses relevant to the branch of study every semester. The departmental committee will finalize and recommend selective courses from the list and further submit for institute approval.

List of NPTEL Courses Recommended:

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Course Title</th>
<th>Duration</th>
<th>Website Link</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>UAV Design - Part II</td>
<td>8 Weeks</td>
<td><a href="https://onlinecourses.nptel.ac.in/noc20_ae04/preview">https://onlinecourses.nptel.ac.in/noc20_ae04/preview</a></td>
</tr>
<tr>
<td>2</td>
<td>Space Flight Mechanics</td>
<td>12 Weeks</td>
<td><a href="https://onlinecourses.nptel.ac.in/noc20_ae06/preview">https://onlinecourses.nptel.ac.in/noc20_ae06/preview</a></td>
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<tr>
<td>3</td>
<td>Aircraft Structures - I</td>
<td>8 Weeks</td>
<td><a href="https://onlinecourses.nptel.ac.in/noc20_ae08/preview">https://onlinecourses.nptel.ac.in/noc20_ae08/preview</a></td>
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<tr>
<td>4</td>
<td>Introduction to Aerospace Engineering</td>
<td>12 Weeks</td>
<td><a href="https://onlinecourses.nptel.ac.in/noc20_ae12/preview">https://onlinecourses.nptel.ac.in/noc20_ae12/preview</a></td>
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<tr>
<td>5</td>
<td>Introduction to Air breathing Propulsion</td>
<td>12 Weeks</td>
<td><a href="https://onlinecourses.nptel.ac.in/noc20_ae13/preview">https://onlinecourses.nptel.ac.in/noc20_ae13/preview</a></td>
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<tr>
<td>6</td>
<td>Introduction to Aircraft Design</td>
<td>12 Weeks</td>
<td><a href="https://onlinecourses.nptel.ac.in/noc20_ae14/preview">https://onlinecourses.nptel.ac.in/noc20_ae14/preview</a></td>
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<tr>
<td>7</td>
<td>Functional and Conceptual Design</td>
<td>12 Weeks</td>
<td><a href="https://onlinecourses.nptel.ac.in/noc20_de10/preview">https://onlinecourses.nptel.ac.in/noc20_de10/preview</a></td>
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<tr>
<td>8</td>
<td>Introduction to robotics</td>
<td>12 Weeks</td>
<td><a href="https://onlinecourses.nptel.ac.in/noc20_de11/preview">https://onlinecourses.nptel.ac.in/noc20_de11/preview</a></td>
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<td>9</td>
<td>Rapid Manufacturing</td>
<td>12 Weeks</td>
<td><a href="https://onlinecourses.nptel.ac.in/noc20_me50/preview">https://onlinecourses.nptel.ac.in/noc20_me50/preview</a></td>
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<tr>
<td>10</td>
<td>Heat Exchangers: Fundamentals and Design Analysis</td>
<td>12 Weeks</td>
<td><a href="https://onlinecourses.nptel.ac.in/noc20_me52/preview">https://onlinecourses.nptel.ac.in/noc20_me52/preview</a></td>
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<td>11</td>
<td>Mechanism And Robot Kinematics</td>
<td>8 Weeks</td>
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<tr>
<td>12</td>
<td>Automation in Manufacturing</td>
<td>12 Weeks</td>
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<td>13</td>
<td>Finite Element Method: Variational Methods to Computer Programming</td>
<td>12 Weeks</td>
<td><a href="https://onlinecourses.nptel.ac.in/noc20_me60/preview">https://onlinecourses.nptel.ac.in/noc20_me60/preview</a></td>
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<td>14</td>
<td>High Performance Computing for Scientists and Engineers</td>
<td>8 Weeks</td>
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<td>15</td>
<td>Introduction to Mechanical Vibration</td>
<td>8 Weeks</td>
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<td>16</td>
<td>Advanced Machining Processes</td>
<td>8 Weeks</td>
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<td>Mechatronics</td>
<td>8 Weeks</td>
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<tr>
<td>18</td>
<td>Steam Power Engineering</td>
<td>8 Weeks</td>
<td><a href="https://onlinecourses.nptel.ac.in/noc20_me87/preview">https://onlinecourses.nptel.ac.in/noc20_me87/preview</a></td>
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<tr>
<td>19</td>
<td>Aircraft Propulsion</td>
<td>12 weeks</td>
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