B. Tech.

IN

MECHANICAL ENGINEERING

FLEXIBLE CURRICULUM

(For students admitted in 2017-18)
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**PROGRAMME CORE**

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**PROGRAMME ELECTIVE**

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**OPEN ELECTIVE**

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**MINOR**

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MEMI15  FUNDAMENTALS OF AUTOMOTIVE TECHNOLOGY  
MEMI17  FUNDAMENTALS OF REFRIGERATION AND AIR CONDITIONING  
MEMI18  PRINCIPLES OF TURBOMACHINERY  
MEMI19  FUNDAMENTALS OF INTERNAL COMBUSTION ENGINES  
MEMI20  ENGINE POLLUTION AND CONTROL  
MEMI22  DYNAMICS  
MEMI23  FUNDAMENTALS OF MECHANICAL DESIGN  

**ESSENTIAL PROGRAMME LABORATORY REQUIREMENT**  
MELR20  SOM/FM LABORATORY  
MELR21  MANUFACTURING TECHNOLOGY LABORATORY  
MELR12  THERMAL ENGINEERING LABORATORY I  
MELR17  COMPUTER AIDED DESIGN LABORATORY  
MELR22  THERMAL ENGINEERING LABORATORY II  
MELR15  DYNAMICS LABORATORY  
MELR16  AUTOMOBILE ENGINEERING LABORATORY  
MELR18  METROLOGY AND QUALITY CONTROL LABORATORY  

**ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)**  
MEHO10  ADVANCED HEAT TRANSFER  
MEHO11  ADVANCED FLUID MECHANICS  
MEHO12  SIMULATION OF IC ENGINES  
MEHO13  DESIGN AND ANALYSIS OF TURBOMACHINES  
MEHO14  ADVANCED ENGINEERING MATERIALS  
MEHO15  DESIGN OF HEAT EXCHANGERS  
MEHO16  DESIGN AND OPTIMIZATION OF THERMAL ENERGY SYSTEMS
CURRICULUM

The total minimum credits for completing the B.Tech. programme in Mechanical Engineering is 179 [68 + 111].

MINIMUM CREDIT REQUIREMENT FOR THE VARIOUS COURSE CATEGORIES

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

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<td>2</td>
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<td>3</td>
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<td>4</td>
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<td>b. Open Electives (OE)</td>
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<td>c. Minor (MI)</td>
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<td>A student should be allowed a minimum of 50% of the total</td>
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TOTAL 179
# (I) GENERAL INSTITUTE REQUIREMENTS

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<td>Chemistry *</td>
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<td>Communication</td>
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<td>6.</td>
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<td>Professional Ethics</td>
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*including Lab

** Commence during Orientation Programme
## I. GENERAL INSTITUTE REQUIREMENTS

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6. ENERGY AND ENVIRONMENTAL ENGINEERING

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8. ENGINEERING GRAPHICS

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9. ENGINEERING PRACTICE

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<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>2.</td>
<td>PRIR11</td>
<td>ENGINEERING PRACTICE</td>
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<td></td>
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</table>

10. BASIC ENGINEERING

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<thead>
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<tbody>
<tr>
<td>1.</td>
<td>CEIR11</td>
<td>BASIC CIVIL ENGINEERING</td>
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<tr>
<td>2.</td>
<td>EEIR11</td>
<td>BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING</td>
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<td></td>
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</table>
11. INTRODUCTION TO COMPUTER PROGRAMMING

<table>
<thead>
<tr>
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<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>1.</td>
<td>CSIR11</td>
<td>BASICS OF PROGRAMMING (Theory &amp; Lab)</td>
<td>3</td>
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12. BRANCH SPECIFIC COURSE

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<tbody>
<tr>
<td>1.</td>
<td>MEIR15</td>
<td>INTRODUCTION TO MECHANICAL ENGINEERING</td>
<td>2</td>
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</table>

13. SUMMER INTERNSHIP

<table>
<thead>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MEIR16</td>
<td>INTERNSHIP / INDUSTRIAL TRAINING / ACADEMIC ATTACHMENT (2 to 3 months duration during summer vacation)</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
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</tr>
</tbody>
</table>

The student should undergo industrial training/internship for a minimum period of two months during the summer vacation of 3rd year. Attachment with an academic institution within the country (IISc/IITs/NITs/IIITs and CFTIs) or university abroad is also permitted instead of industrial training.

# To be evaluated at the beginning of VII semester by assessing the report and seminar presentations.

14. PROJECT WORK

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MEIR17</td>
<td>PROJECT WORK</td>
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15. COMPREHENSIVE VIVA

<table>
<thead>
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<th>Credits</th>
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<tr>
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<td>MEIR18</td>
<td>COMPREHENSIVE VIVA</td>
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16. INDUSTRIAL LECTURE

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<thead>
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<tbody>
<tr>
<td>1.</td>
<td>MEIR19</td>
<td>INDUSTRIAL LECTURE</td>
<td>1</td>
</tr>
</tbody>
</table>

Total 1

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.

17. NSS / NCC / NSO

<table>
<thead>
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<th>Sl. No.</th>
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<th>Course Title</th>
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Total 0
(II) PROGRAMME CORE (PC)

[Note: (1) Number of programme core: 16 to 20 (2) Credits: 56 - 65]

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MEPC10</td>
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<td>-NIL-</td>
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<td>2.</td>
<td>MEPC11</td>
<td>ENGINEERING THERMODYNAMICS</td>
<td>-NIL-</td>
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<td>3.</td>
<td>MEPC12</td>
<td>STRENGTH OF MATERIALS</td>
<td>-NIL-</td>
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<tr>
<td>4.</td>
<td>MEPC13</td>
<td>APPLIED ELECTRICAL AND ELECTRONICS ENGINEERING</td>
<td>EEIR11</td>
<td>4</td>
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<td>5.</td>
<td>MEPC14</td>
<td>INSTRUMENTATION AND CONTROL ENGINEERING</td>
<td>-NIL-</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>MEPC16</td>
<td>THERMAL ENGINEERING</td>
<td>MEPC11</td>
<td>3</td>
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<tr>
<td>7.</td>
<td>MEPC17</td>
<td>MECHANICS OF MACHINES - I</td>
<td>MEPC10</td>
<td>3</td>
</tr>
<tr>
<td>8.</td>
<td>MEPC18</td>
<td>FLUID MECHANICS</td>
<td>-NIL-</td>
<td>3</td>
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<tr>
<td>9.</td>
<td>MEPC20</td>
<td>ENGINEERING MATERIALS</td>
<td>-NIL-</td>
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<td>10.</td>
<td>MEPC21</td>
<td>TURBOMACHINES</td>
<td>MEPC18</td>
<td>3</td>
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<tr>
<td>11.</td>
<td>MEPC22</td>
<td>HEAT AND MASS TRANSFER</td>
<td>MEPC11</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td>MEPC23</td>
<td>MECHANICS OF MACHINES - II</td>
<td>MEPC17</td>
<td>3</td>
</tr>
<tr>
<td>13.</td>
<td>MEPC24</td>
<td>ANALYSIS AND DESIGN OF MACHINE COMPONENTS</td>
<td>MEPC12</td>
<td>3</td>
</tr>
<tr>
<td>14.</td>
<td>MEPC25</td>
<td>AUTOMOBILE ENGINEERING</td>
<td>-NIL-</td>
<td>3</td>
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<tr>
<td>15.</td>
<td>MEPC26</td>
<td>DESIGN OF MECHANICAL DRIVES</td>
<td>MEPC12</td>
<td>3</td>
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<tr>
<td>16.</td>
<td>MEPC27</td>
<td>COMPUTER AIDED DESIGN AND DRAFTING</td>
<td>MEIR12</td>
<td>3</td>
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<tr>
<td>17.</td>
<td>MEPC28</td>
<td>POWER PLANT ENGINEERING</td>
<td>MEPC21</td>
<td>3</td>
</tr>
<tr>
<td>18.</td>
<td>MEPC29</td>
<td>METROLOGY AND QUALITY CONTROL</td>
<td>-NIL-</td>
<td>3</td>
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<td>19.</td>
<td>MEPC30</td>
<td>MANUFACTURING TECHNOLOGY</td>
<td>-NIL-</td>
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<td>20.</td>
<td>MEPC31</td>
<td>MACHINE DRAWING</td>
<td>MEIR12</td>
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</table>

**Total** 62
(III) ELECTIVES

a. PROGRAMME ELECTIVE (PE)

[Note: Number of programme elective: at least 3 courses]

Students pursuing B.Tech. in Mechanical Engineering should take at least three courses from the Programme Electives listed below.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>MEPE10</td>
<td>COMPRESSIBLE FLOW AND JET PROPULSION</td>
<td>MEPC18</td>
<td>3</td>
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<tr>
<td>2.</td>
<td>MEPE11</td>
<td>COMPUTATIONAL FLUID DYNAMICS</td>
<td>MEPC18</td>
<td>3</td>
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<tr>
<td>3.</td>
<td>MEPE12</td>
<td>ADVANCED IC ENGINES</td>
<td>MEPC16</td>
<td>3</td>
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<td>4.</td>
<td>MEPE13</td>
<td>COMBUSTION ENGINEERING</td>
<td>MEPC16</td>
<td>3</td>
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<tr>
<td>5.</td>
<td>MEPE14</td>
<td>BIOFUELS</td>
<td>MEPC16</td>
<td>3</td>
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<tr>
<td>6.</td>
<td>MEPE15</td>
<td>REFRIGERATION AND AIR CONDITIONING</td>
<td>MEPC16</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>MEPE16</td>
<td>FUNDAMENTALS OF HVAC SYSTEMS</td>
<td>MEPC16</td>
<td>3</td>
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<tr>
<td>8.</td>
<td>MEPE18</td>
<td>NANO TECHNOLOGY</td>
<td>MEPC20</td>
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<tr>
<td>9.</td>
<td>MEPE19</td>
<td>VEHICLE DYNAMICS</td>
<td>MEPC25</td>
<td>3</td>
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<tr>
<td>10.</td>
<td>MEPE21</td>
<td>DYNAMICS OF MACHINERY</td>
<td>MEPC23</td>
<td>3</td>
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<tr>
<td>11.</td>
<td>MEPE22</td>
<td>MEMS DEVICES – DESIGN AND FABRICATION</td>
<td>MEPC13</td>
<td>3</td>
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<td>12.</td>
<td>MEPE24</td>
<td>OIL HYDRAULICS AND PNEUMATICS</td>
<td>MEPC18</td>
<td>3</td>
</tr>
<tr>
<td>13.</td>
<td>MEPE25</td>
<td>INDUSTRIAL ROBOTICS</td>
<td>MEPC13</td>
<td>3</td>
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<tr>
<td>14.</td>
<td>MEPE26</td>
<td>MECHATRONICS</td>
<td>MEPC13</td>
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<tr>
<td>15.</td>
<td>MEPE27</td>
<td>INDUSTRIAL TRIBOLOGY</td>
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<td>3</td>
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<tr>
<td>16.</td>
<td>MEPE29</td>
<td>RENEWABLE ENERGY SOURCES</td>
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</table>
b. OPEN ELECTIVE (OE)

<table>
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<th>Credits</th>
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<tbody>
<tr>
<td>1.</td>
<td>MEOE11</td>
<td>FINITE ELEMENT METHOD</td>
<td>-NIL-</td>
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<tr>
<td>2.</td>
<td>MEOE12</td>
<td>COMPOSITE MATERIALS</td>
<td>-NIL-</td>
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<tr>
<td>3.</td>
<td>MEOE13</td>
<td>ADVANCES IN WELDING TECHNOLOGY</td>
<td>-NIL-</td>
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</tr>
<tr>
<td>4.</td>
<td>MEOE14</td>
<td>INDUSTRIAL SAFETY ENGINEERING</td>
<td>-NIL-</td>
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<tr>
<td>5.</td>
<td>MEOE15</td>
<td>OPTIMIZATION IN ENGINEERING DESIGN</td>
<td>-NIL-</td>
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<tr>
<td>6.</td>
<td>MEOE16</td>
<td>CRYOGENIC ENGINEERING</td>
<td>-NIL-</td>
<td>3</td>
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<tr>
<td>7.</td>
<td>MEOE17</td>
<td>ENERGY CONSERVATION AND MANAGEMENT</td>
<td>-NIL-</td>
<td>3</td>
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<tr>
<td>8.</td>
<td>MEOE18</td>
<td>ENERGY STORAGE TECHNOLOGY</td>
<td>-NIL-</td>
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<td>9.</td>
<td>MEOE19</td>
<td>VEHICLE EMISSIONS AND CONTROL</td>
<td>-NIL-</td>
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</table>

c. MINOR (MI)

Students who have registered for B.Tech Minor in Mechanical Engineering.

[Note: Number of Minor courses: 5 courses (Minimum)]

<table>
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<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisites</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1.</td>
<td>MEMI10</td>
<td>BASIC THERMODYNAMICS</td>
<td>-NIL-</td>
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<tr>
<td>2.</td>
<td>MEMI11</td>
<td>FUNDAMENTALS OF THERMAL ENGINEERING</td>
<td>-NIL-</td>
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</tr>
<tr>
<td>3.</td>
<td>MEMI12</td>
<td>FLUID MECHANICS AND MACHINERY</td>
<td>-NIL-</td>
<td>3</td>
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<tr>
<td>4.</td>
<td>MEMI13</td>
<td>FUNDAMENTALS OF HEAT AND MASS TRANSFER</td>
<td>-NIL-</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
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<td>MACHINE DESIGN</td>
<td>-NIL-</td>
<td>3</td>
</tr>
<tr>
<td>6.</td>
<td>MEMI15</td>
<td>FUNDAMENTALS OF AUTOMOTIVE TECHNOLOGY</td>
<td>-NIL-</td>
<td>3</td>
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<tr>
<td>7.</td>
<td>MEMI17</td>
<td>FUNDAMENTALS OF REFRIGERATION AND AIR CONDITIONING</td>
<td>-NIL-</td>
<td>3</td>
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<tr>
<td>8.</td>
<td>MEMI18</td>
<td>PRINCIPLES OF TURBOMACHINERY</td>
<td>-NIL-</td>
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<tr>
<td>9.</td>
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<td>FUNDAMENTALS OF INTERNAL COMBUSTION ENGINES</td>
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<td>MEMI20</td>
<td>ENGINE POLLUTION AND CONTROL</td>
<td>-NIL-</td>
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<tr>
<td>11.</td>
<td>MEMI22</td>
<td>DYNAMICS</td>
<td>-NIL-</td>
<td>3</td>
</tr>
<tr>
<td>12.</td>
<td>MEMI23</td>
<td>FUNDAMENTALS OF MECHANICAL DESIGN</td>
<td>-NIL-</td>
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</tbody>
</table>
Note: Student should be allowed a minimum of 50% of the total electives of a programme from Open electives and Minor, if so desired by the student.

(IV) ESSENTIAL PROGRAMME LABORATORY REQUIREMENT (ELR)

<table>
<thead>
<tr>
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<th>Course Code</th>
<th>Course Title</th>
<th>Co requisites</th>
<th>Credits</th>
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<td>THERMAL ENGINEERING LABORATORY I</td>
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<tr>
<td>2.</td>
<td>MELR15</td>
<td>DYNAMICS LABORATORY</td>
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<tr>
<td>3.</td>
<td>MELR16</td>
<td>AUTOMOBILE ENGINEERING LABORATORY</td>
<td>MEPC25</td>
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<td>4.</td>
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<td>COMPUTER AIDED DESIGN LABORATORY</td>
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<td>2</td>
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<td>5.</td>
<td>MELR18</td>
<td>METROLOGY AND QUALITY CONTROL LABOR</td>
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<td>6.</td>
<td>MELR20</td>
<td>SOM/FM LABORATORY</td>
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<td>MANUFACTURING TECHNOLOGY LAB</td>
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<td>MELR22</td>
<td>THERMAL ENGINEERING LABORATORY II</td>
<td>MEPC22</td>
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</tbody>
</table>

Total: 16

NOTE: Students can register for 2 laboratory courses during one session along with regular courses (PC / PE / OE / MI).

ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)
A student can obtain B.Tech. (Honours) degree provided the student has;

i. Registered at least for 12 theory courses and 2 ELRs in the second year.

ii. Consistently obtained a minimum GPA of 8.5 in the first four sessions

iii. Continue to maintain the same GPA of 8.5 in the subsequent sessions (including the Honours courses)

iv. Completed 3 additional theory courses specified for the Honors degree of the programme.

v. Completed all the courses registered, in the first attempt and in four years of study.

<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>MEHO10</td>
<td>ADVANCED HEAT TRANSFER</td>
<td>MEPC22</td>
<td>3</td>
</tr>
<tr>
<td>2.</td>
<td>MEHO11</td>
<td>ADVANCED FLUID MECHANICS</td>
<td>MEPC18</td>
<td>3</td>
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<tr>
<td>3.</td>
<td>MEHO12</td>
<td>SIMULATION OF IC ENGINES</td>
<td>MEPC16</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>MEHO13</td>
<td>DESIGN AND ANALYSIS OF TURBO MACHINES</td>
<td>MEPC21</td>
<td>3</td>
</tr>
<tr>
<td>5.</td>
<td>MEHO14</td>
<td>ADVANCED ENGINEERING MATERIALS</td>
<td>MEPC20</td>
<td>3</td>
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<tr>
<td>6.</td>
<td>MEHO15</td>
<td>DESIGN OF HEAT EXCHANGERS</td>
<td>MEPC22</td>
<td>3</td>
</tr>
<tr>
<td>7.</td>
<td>MEHO16</td>
<td>DESIGN AND OPTIMIZATION OF THERMAL ENERGY SYSTEMS</td>
<td>MEPC16</td>
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</tbody>
</table>
DESCRIPTION OF COURSE CODES FOR B.TECH. PROGRAMME

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Type of the course</th>
<th>Course Code and range</th>
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<tbody>
<tr>
<td>1.</td>
<td>General Institute requirements</td>
<td>xxIR10 to 99</td>
</tr>
<tr>
<td>2.</td>
<td>Programme core</td>
<td>xxPC10 to 99</td>
</tr>
<tr>
<td>3.</td>
<td>Programme Elective</td>
<td>xxPE10 to 99</td>
</tr>
<tr>
<td>4.</td>
<td>Essential Laboratory Requirement</td>
<td>xxLR10 to 99</td>
</tr>
<tr>
<td>5.</td>
<td>Open Electives</td>
<td>xxOE10 to 99</td>
</tr>
<tr>
<td>6.</td>
<td>Minors</td>
<td>xxMI10 to 99</td>
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<tr>
<td>7.</td>
<td>Honours</td>
<td>xxHO10 to 99</td>
</tr>
</tbody>
</table>

where xx denotes the Department offering the course

DESCRIPTION OF DEPARTMENT CODES FOR B.TECH. PROGRAMME

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### Semester wise curriculum

#### Semester I

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**Total Credits** 24
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**Total Credits**

| Credits | 23 |

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**Total Credits**

| Credits | 22 |
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Total Credits: 23

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**Total Credits**

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**Total Credits**

|               |       | **23** |
Semester VIII

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Total Credits 18
SYLLABUS

I. GENERAL INSTITUTE REQUIREMENTS

1. MATHEMATICS

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Course Learning Objectives:

Objective of the course is to
1. determine canonical form of given quadratic form.
2. discuss the convergence of infinite series.
3. analyze and discuss the extrema of the functions of several variables.
4. evaluate the multiple integrals and apply in solving problems.

Course Content


Double integral – Changing the order of Integration – Change of variables from Cartesian to Polar Coordinates – Area using double integral in Cartesian and Polar Coordinates – Triple integral – Change of Variables from Cartesian to Spherical and Cylindrical Coordinates – Volume using double and triple integrals.

Course Outcomes:

After the completion of the course, students would be able to
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 test.
4. compute partial derivatives of function of several variables
5. write Taylor’s series for functions with two variables.
6. evaluate multiple integral and its applications in finding area, volume.
Reference Books

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<tr>
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Course Learning Objectives:

Objective of the course is to
1. Introduce the structure vector space and various operations on it.
2. Introduce different method to solve the 2nd order differential equations and its applications in electric circuit problems.
3. familiarize concepts like differentiations and integration for function of complex variable.
4. Introduce vector differential operator for vector function and important theorems on vector functions to solve engineering problems.

Course Content


Basic review of first order differential equation - Higher order linear differential equations with constant coefficients – Particular integrals for \( x^n e^{ax}, e^{ax} \cos(bx), e^{ax} \sin(bx) \) – Equation reducible to linear equations with constant coefficients using \( x = e^t \) - Simultaneous linear equations with constant coefficients – Method of variation of parameters – Applications – Electric circuit problems.

Gradient, Divergence and Curl – Directional Derivative – Tangent Plane and normal to surfaces – Angle between surfaces –Solenoidal and irrotational fields – Line, surface and volume integrals – Green’s Theorem, Stokes’ Theorem and Gauss Divergence Theorem (all without proof) – Verification and applications of these theorems.

Analytic functions – Cauchy – Riemann equations (Cartesian and polar) –Properties of analytic functions – Construction of analytic functions given real or imaginary part – Conformal mapping of standard elementary functions \( z^2, e^z, \sin z, \cos z, z + \frac{k^2}{z} \) and bilinear transformation.
Cauchy’s integral theorem, Cauchy’s integral formula and for derivatives— Taylor’s and Laurent’s expansions (without proof) – Singularities – Residues – Cauchy’s residue theorem – Contour integration involving unit circle.

**Course Outcomes:**

After the completion of the course, students are able to
1. Perform standard operation in finite dimensional vector spaces
2. Compute the dot product of vectors, lengths of vectors, and angles between vectors.
3. Perform gradient, div, curl operator on vector functions and give physical interpretations.
4. Use Green’s, Gauss divergence and Stoke’s theorems to solve engineering problems.
5. solve higher order ODEs and interpret it geometrically.
7. Construct analytic function for given real or imaginary part of it.
8. find images of the given region by standard functions of complex variable.
9. compute bilinear map by knowing the images of three points.

**Reference Books:**

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<td>Course Title</td>
<td>TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS</td>
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</table>

**Course Learning Objectives**

students completing this course will be able to
1. understand the importance of transform techniques to solve engineering problems.
2. apply Laplace and Fourier transform to solve the mathematical equations arising in mechanical engineering.
3. understand Fourier series analysis and its use in solving boundary value problems.
4. understand and solve the partial differential equations.
5. construct mathematical model of some heat transfer problem and vibration of an elastic string.
Course Content

Laplace Transform of Standard functions, derivatives and integrals – Inverse Laplace transform - Convolution theorem-Periodic functions – Application to ordinary differential equations and simultaneous equations with constant coefficients and integral equations.

Fourier series - Dirichlet's conditions - Half range Fourier cosine and sine series - Parseval's relation
- Fourier series in complex form – Harmonic analysis.


Formation of partial differential equations eliminating arbitrary constants and functions - solution of first order equations - four standard types - Lagrange's equation - homogeneous and non-homogeneous type of second order linear differential equation with constant coefficients.

One-dimensional wave equation and one-dimensional heat flow equation - method of separation of variables - Fourier series solution.

Course outcomes:

Completion of the course, students should be able to
1. Compute Laplace and inverse Laplace transform of functions.
2. Apply Laplace transform to solve ordinary differential equations.
3. Compute Fourier and inverse Fourier transform of functions.
4. Compute Fourier series of given function and interpret its coefficients.
5. Able to form partial differential equation for given family of surfaces.
6. Compute solution of few types of linear and non-linear first order/second order PDEs.
8. Construct mathematical model of vibration of elastic sting (one dimensional) and solution of it.

Reference Books:
Course Code: MAIR41
Course Title: NUMERICAL TECHNIQUES
Number of Credits: 3
Prerequisites: MAIR11, MAIR21, MAIR31/MAIR32
Course Type: GENERAL INSTITUTE REQUIREMENTS

Course Learning Objectives: To introduce
1. Numerical Methods for Solving Linear Systems
2. Methods to solve equations of One Variable as well as system of equations with two variables.
3. Interpolating Polynomials and best curve fitting methods for the given data.
4. Numerical Differentiation and Integration
5. Numerical Solutions of Ordinary 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.

Solution of nonlinear equation - Bisection method - Secant method - Regula falsi method - Newton-Raphson method for \( f(x) = 0 \) and for \( f(x,y) = 0, g(x,y) = 0 \) - Order of convergence - Horner's method - Graeffe's method - Bairstow's method.


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.

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 \( f(x)=0 \) and nonlinear equations with two variables,
4. interpolate function and approximate the function by polynomial.
5. compute numerical differentiation and integration of \( f(x) \).
6. compute best curve fit for the given data by curve fitting method.
7. compute numerical solution of ordinary differential equations by finite difference method.
8. compute numerical solution of partial differential equations by finite difference method.
Reference Books:


2. PHYSICS

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Course Learning Objectives

1. To introduce the notions of light matter interaction, fabrication of lasers, light propagation in waveguides, applications of lasers and optical fibers.

2. To understand the fundamentals of acoustics, crystal physics and structure determination of crystals.

3. To learn the fundamentals of magnetic, electrical and superconducting materials.

4. To introduce the thoughts of special theory of relativity.

Course Content

Lasers

Fiber Optics

Acoustics
Crystallography
Seven crystal systems and Bravais lattices– Miller indices – interplanar distance–symmetry operation -Bragg’s law of X-ray diffraction –Laue Method- powder crystal method- structure determination for cubic system.

Magnetic materials, conductors and superconductors
Conductors: classical free electron theory (Lorentz –Drude theory) – electrical conductivity

Special theory of relativity
Lorentz transformation - length contraction- mass-energy relation.

Course Outcomes
Students will be able to know principle, construction of lasers, light propagation in optical fibers and their applications. Students will understand the acoustics of building, ultrasonics, crystal systems and structure determination. Students will also appreciate various materials properties like electrical, magnetic and superconducting. Students will also establish mass-energy relationship through special theory of relativity.

References

Laboratory Experiments
1. Torsional pendulum
2. Numerical aperture of an optical fiber
3. Temperature measurement - Thermocouple
4. Specific rotation of a liquid – Half Shade Polarimeter
5. Thickness of a thin wire – Air Wedge
6. Conversion of galvanometer into ammeter and voltmeter
7. Dispersive power of a prism – Spectrometer
8. Superconductivity- measurement of transition temperature
9. Kundt’s tube experiment

References
Course Code : PHIR12
Course Title : PHYSICS II
Number of Credits : 4
Prerequisites
(Course code) : -NIL-
Course Type : GENERAL INSTITUTE REQUIREMENTS

Course Learning Objectives

1. To introduce the concepts of matter waves, wave functions and its interpretation to understand the matter at atomic scale.

2. To understand the fundamentals of nuclear forces, models and classification of matter.

3. To know the basics of advanced materials and their applications.

4. To introduce the concepts of NDT, vacuum pumps and their applications.

Course Content

Quantum Mechanics

Nuclear and Particle Physics
Nuclear properties and forces - Nuclear models - Shell model - Nuclear reaction - Radioactivity - types and half-lives - Stellar nucleosynthesis. Fundamental forces - Particle physics - classification of matter - quark model - neutrino properties and their detection.

Advanced Materials
Shape memory alloys-one way and two-way memory effect- pseudoelasticity-applications.

Non-Destructive Testing
Vacuum Technology

Course Outcomes

Students will be able to experience the behaviour of matter at atomic scale, role of nuclear and particle physics in applications like radioactivity and nuclear reactions. Students will also get an exposure to nanomaterial synthesis, liquid crystal display and shape memory alloys. Students will also familiarize various NDT methods, vacuum pumps and their applications.

References


3. CHEMISTRY

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Course Learning Objectives

1. To introduce the students to basic principles of chemical bonding, coordination chemistry, reaction mechanism, stereochemical aspects of organic compounds.
2. To provide a brief outline on the types and applications of polymers.

Course Content

Chemical Bonding
Basic concepts of bonding and applications: VBT, VSEPR theory, MO Theory. Intermolecular interactions-ion ion interactions, ion-dipole interactions, hydrogen bonding, dipole-dipole interactions, London / dispersion forces, relative strength of intermolecular forces; Consequences- surface tension.
Coordination and Organometallic Chemistry

Basic organic reactions and mechanism

Stereochemistry & Aromaticity
Representations of three dimensional structures - Types of Isomerism - configurations and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Applications of chirality in drug molecules. Aromaticity, Huckels rule of aromaticity and anti-aromaticity, annulenes, heteroannulenes.

Polymers and Composites
Concept of macromolecules-Nomenclature of polymers-Tacticity- Polymerization processes-Mechanism-Types of Polymerization-Classification of Polymers-Effect of Polymer structure on properties-Moulding of plastics into articles-Important addition and condensation polymers – synthesis and properties – Molecular mass determination of polymers- Static and dynamic methods, Light scattering and Gel Permeation Chromatography-Rubbers – Vulcanization – Synthetic rubbers – Conducting polymers-Composite materials – Reinforced composites and processing.

Course Outcome
Students will learn about the fundamentals and needs of chemical bonding, coordination chemistry, polymers and composites. They will be familiarizing with basics of reaction mechanism and stereochemical aspects of organic molecules.

Practical (Laboratory Experiments):
1. Determination of reaction kinetics of hydrolysis of an ester.
2. Estimation of carbonate, non-carbonate and total hardness in the given water sample.
3. Percentage purity of bleaching powder.
4. Determination of the percentage of Fe in the given steel sample.
5. Estimation of Ca in limestone.
6. Estimation of Fe3+ by spectrophotometer.

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 to determine the reaction kinetics, estimate various components from corresponding bulk mixture.
Reference Books
1. PW Atkins and J de Paula, Physical Chemistry by, Oxford University Press.

Course Code : CHIR13
Course Title : CHEMISTRY II
Number of Credits : 4
Prerequisites : -NIL-
(Course code)
Course Type : GENERAL INSTITUTE REQUIREMENTS

Course Learning Objectives
To introduce the students to basic principles of electrochemistry, cell construction and evaluation, corrosion, adsorption, phase equilibrium and engineering materials of importance

Course Content

Unit-I: Electrochemistry
Conductivity of electrolytes- Specific, molar and equivalent conductivity, Nernst equation for electrode potential, EMF series, hydrogen electrode, calomel electrode, glass electrode, Electrolytic and galvanic cells, cell EMF, its measurement and applications, Weston standard cell, reversible and irreversible cells, concentration cell, electrode (hydrogen gas electrode) and electrolyte concentration cell, concentration cell with and without transference, fuel cells, hydroxy fuel cell.

Unit-II: Corrosion
Dry corrosion and wet corrosion, mechanisms, types of corrosion, DMC, DAC, stress, inter granular, atmospheric and soil corrosion, Passivity, Polarization, over potential and its significance, Factors affecting corrosion, protection from corrosion by metallic coatings, electroplating, electroless plating and cathodic protection, Chemical conversion coatings and organic coatings- Paints, enamels.

Unit-III: Surface Chemistry
Unit-IV: Engineering Materials

Unit-V: Polymers and Composites
Concept of macromolecules-Nomenclature of polymers-Tacticity- Polymerization processes-Mechanism-Types of Polymerization-Classification of Polymers-Effect of Polymer structure on properties-Moulding of plastics into articles-Important addition and condensation polymers – synthesis and properties – Molecular mass determination of polymers- Static and dynamic methods, Light scattering and Gel Permeation Chromatography-Rubbers –Vulcanization – Synthetic rubbers – Conducting polymers Composite materials – Reinforced composites and processing.

Laboratory Experiments
1. Corrosion rate by polarization technique
2. Conductometric titration
3. Potentiometric titration
4. pH metric titration
5. Percentage purity of bleaching powder
6. Percentage purity of washing soda
7. Determination of molecular weight of polymer by viscometry
8. Demonstration of sophisticated instruments and assignments on them

Reference Books:

Course Outcomes
At the end of the course student will learn the significance of electrochemistry and its application, corrosion, adsorption, engineering materials of importance and polymer.

4. HUMANITIES

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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.


References:


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.
5. COMMUNICATION

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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

An introduction - Its role and importance in the corporate world – Tools of communication – Barriers – Levels of communication – English for Specific purposes and English for technical purposes.

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


Effective writing practice – Vocabulary expansion - Effective sentences: role of acceptability, appropriateness, brevity & clarity in writing – Cohesion & coherence in writing –Writing of definitions, descriptions & instructions - Paragraph writing - Introduction to report writing.

Reference Books:


Course Outcomes

At the end of the course student will be able to express themselves in a meaningful manner to different levels of people in their academic and social domains.
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 their professional needs.

Course Content

Listening Barriers to listening: Physical & psychological – Steps to overcome them – Purposive listening practice – Active listening and anticipating the speaker – Use of technology in the professional world.


Writing Professional Correspondence – Formal and informal letters – Argument Writing practice – Perspectives in writing – Narrative writing -Different registers - Tone in formal writing – Summary writing practice- Introduction to reports.

Study Skills Reference Skills - Use of dictionary, thesaurus etc – Importance of contents page, cover & back pages – Bibliography.

Reference Books:


Course Outcomes

At the end of the course student will be able to get knowledge of the various uses of English in their professional environment and they will be able to communicate themselves effectively in their chosen profession.
6. ENERGY AND ENVIRONMENTAL ENGINEERING

| Course Code | : | ENIR11 |
| Course Title | : | ENERGY AND ENVIRONMENTAL ENGINEERING |
| Number of Credits | : | 2 |
| Prerequisites | : | -NIL- |
| (Course code) | : | |
| Course Type | : | GENERAL INSTITUTE REQUIREMENTS |

Course Learning Objectives

1. To teach the principal renewable energy systems.
2. 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- Off shore Wind energy- 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 Outcomes

At the end of the course student 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.

7. PROFESSIONAL ETHICS

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<td>GENERAL INSTITUTE REQUIREMENTS</td>
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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.,.
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.

**Geometrical constructions** Dividing a given straight line into any number of equal parts, bisecting a given angle, drawing a regular polygon given one side, special methods of constructing a pentagon and hexagon – conic sections – ellipse – parabola – hyperbola - cycloid– trochoid.

**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 or 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.

**Computer aided drafting** Introduction to computer aided drafting package to make 2-D drawings.

**Reference Books:**


**Course Outcomes**

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.

### 9. ENGINEERING PRACTICE

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**Course Learning Objective**

Introduction to the use of tools and machinery in Carpentry, Welding, Foundry, Fitting and Sheet Metal Working.
Course Content

Carpentry
Wood sizing exercise in planning, marking, sawing, chiseling and grooving to make
1. Half lap joint
2. Cross lap joint

Welding
Exercise in arc welding for making
1. Lap joint
2. Butt joint

Foundry
Preparation of sand mould for the following
1. Flange
2. Anvil

Fitting
Preparation of joints, markings, cutting and filling for making
1. V-joint
2. T-joint

Sheet metal
Making of small parts using sheet metal
1. Tray
2. Funnel

Course Outcome

At the end of the course student will be able to
1. To provide hands on exercises in common carpentry works associated with residential and industrial buildings.
2. To expose the students regarding pipe connection for pumps & turbines and to study the joint used in roofs, doors, windows and furnitures.
3. To provide hands on exercise on basic welding, machining and sheet metal works.
4. To provide exposure regarding smithy, foundry operations and in latest welding operations such as TIG, MIG, CO2, spot welding etc.

10. BASIC ENGINEERING

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>: BASIC CIVIL ENGINEERING</td>
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<tr>
<td>Number of Credits</td>
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<td>Prerequisites</td>
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<td>(Course code)</td>
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<tr>
<td>Course Type</td>
<td>: GENERAL INSTITUTE REQUIREMENTS</td>
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</table>
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


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

Structural Systems and Recent Developments, Roads-Classification of Rural and urban Roads-Pavement Materials-Traffic signs and Road Marking-Traffic Signals.

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.

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.

Reference Books

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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>: EEIR11</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>: BASICSOF ELECTRICALANDELECTRONICS ENGINEERING</td>
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<tr>
<td>Number of Credits</td>
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<tr>
<td>Course Type</td>
<td>: GENERAL INSTITUTE REQUIREMENTS</td>
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</tbody>
</table>
Course Learning Objective

1. This course aims to equip the students with a basic understanding of Electrical circuits and machines for specific types of applications.
2. The course gives a comprehensive exposure to house wiring.
3. 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, fluorescent 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

At the end of the course, students will be able to 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.

### 11. INTRODUCTION TO COMPUTER PROGRAMMING

<table>
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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>:</td>
<td>BASICS OF PROGRAMMING (Theory &amp; Lab)</td>
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<tr>
<td>Number of Credits</td>
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<td>Course Type</td>
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<td>GENERAL INSTITUTE REQUIREMENTS</td>
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</table>
Course Learning Objective

1. To learn the fundamentals of computers.
2. To learn the problem solving techniques writing algorithms and procedures.
3. To learn the syntax and semantics for C programming language
4. To develop the C code for simple logic
5. To understand the constructs of structured programming including conditionals and iterations

Course Content

Introduction to computers – Computer Organization – Characteristics – Hardware and Software – Modes of operation – Types of programming languages – Developing a program.


Modular Programming – Functions and Procedures – Examples – Parameter passing methods.


Laboratory Experiments

1. Programs using sequence construct
2. Programs using selection construct
3. Programs using Iterative construct
4. Programs using nested for loops
5. Programs using functions with Pass by value
6. Programs using functions with Pass by reference
7. Programs using recursive functions
8. Programs using one dimensional Array
9. Programs using two dimensional Arrays
10. Programs using Pointers and functions
11. Programs using Pointers and Arrays

Reference Books:

2. R.G.Dromey, ‘How to Solve it By Computers?’, Prentice Hall, 2001
Course Outcome

At the end of the course, student will be
1. Ability to write algorithms for problems
2. Knowledge of the syntax and semantics of C programming language
3. Ability to code a given logic in C language
4. Knowledge in using C language for solving problems

12. BRANCH SPECIFIC COURSE

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<tr>
<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>INTRODUCTION TO MECHANICAL ENGINEERING</td>
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<td>Number of Credits</td>
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<td>Course Type</td>
<td>GENERAL INSTITUTE REQUIREMENTS</td>
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</tbody>
</table>

Course Learning Objective

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.

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.

Reference Books:

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

13. SUMMER INTERNSHIP

<table>
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<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>INTERNSHIP/INDUSTRY/TRAINING/ACADEMIC ATTACHMENT (2 to 3 Months duration during summer vacation)</td>
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<tr>
<td>Number of Credits</td>
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<td>Course Type</td>
<td>GENERAL INSTITUTE REQUIREMENTS</td>
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</tbody>
</table>

Course Learning Objective

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.
14. PROJECT WORK

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<td>Course Title</td>
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</tbody>
</table>

Course Learning Objective

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.

Course Outcome

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.

15. COMPREHENSIVE VIVA

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<tr>
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<td>Course Type</td>
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</table>

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.
16. INDUSTRIAL LECTURE

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<td>Course Title</td>
<td>INDUSTRIAL LECTURE</td>
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<td>Course Type</td>
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</tbody>
</table>

Course Learning Objective

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.

17. NSS/NCC/NSO

<table>
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<tr>
<th>Course Code</th>
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<tr>
<td>Course Type</td>
<td>GENERAL INSTITUTE REQUIREMENTS</td>
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</tbody>
</table>

Course Learning Objective

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)

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<tr>
<th>Course Code</th>
<th>MEPC10</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>ENGINEERING MECHANICS</td>
</tr>
<tr>
<td>Number of Credits</td>
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<td>-NIL-</td>
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<tr>
<td>Course Type</td>
<td>PROGRAMME CORE</td>
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</tbody>
</table>

Course Learning Objectives

1. To explain the importance of mechanics in the context of engineering and conservation equations
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 cables and trusses.
5. To understand the basic principles of dynamics.

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**

The terminal objectives of the course is that, on successful completion of teaching-learning and evaluation activities, a student would be able to identify and analyze the problems by applying the fundamental principles of engineering mechanics and to proceed to research, design and development of various engineering systems.

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<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>: ENGINEERING THERMODYNAMICS</td>
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<tr>
<td>Number of Credits</td>
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<td>Course Type</td>
<td>: PROGRAMME CORE</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**

Review of basic concepts of thermodynamics, properties of pure substances - First law applied to control mass, control volumes. Steady flow energy equation (SFEE) - applications of SFEE - Uniform state, Uniform flow- Zeroth law of thermodynamics and temperature scales.

Second law statements - irreversible processes, Carnot theorem, Clausius Inequality — Entropy, Entropy change for pure substances – T-S diagram, Entropy change applied to control mass, control volume-Availability and irreversibility.

Vapour power cycles - Rankine cycle - Effect of pressure and temperature on Rankine cycle - Reheat cycle - Regenerative cycle, Vapor compression refrigeration cycle. Air standard power cycles - Assumptions regarding air standard cycles - Otto, Diesel, Dual, Stirling and Brayton cycles.


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.

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<tr>
<td>Course Title</td>
<td>: STRENGTH OF MATERIALS</td>
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<td>: -NIL-</td>
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<tr>
<td>(Course code)</td>
<td>: PROGRAMME CORE</td>
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</table>

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. Analyse and design structural member subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behaviour of materials.
2. Present the concept of shear force, bending moment, slope and deflection and their use in machine design.
3. Understand the mohr’s circle and be able to determine principle stresses.
4. Calculate the stresses and strain associated with thin wall spherical & cylindrical pressure vessels and types of springs.

Course Code : MEPC18
Course Title : FLUID MECHANICS
Number of Credits : 3
Prerequisites : MAIR21
(Course code)
Course Type : PROGRAMME CORE

Course Learning Objectives

1. To familiarize with the properties of fluids and the applications of fluid mechanics.
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 familiarize students with the relevance of fluid dynamics to many engineering systems

Course Content

Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure, 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, Laplace equation, equipotential lines flow nets, uses and limitations.
Dynamics of Fluid flow: Fluid Dynamics: Energies in flowing fluid, head, pressure, dynamic, static and total head, Control volume analysis of mass, momentum and energy. RTT, Equations of fluid dynamics: Differential equations of mass, energy and momentum (Euler’s equation), Navier-Stokes equations (without proof), Bernoulli’s equation and its applications, Velocity measurements: Pitot tube and Pitot-static tube.

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 Hydraulic similitude: Dimensional analysis, Buckingham’s theorem, important dimensionless numbers and their significance, geometric, Kinematic and dynamic similarity, model studies. Froude, Reynolds, Weber, Cauchy and Mach numbers, Applications and limitations of model testing, simple problems only.

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.
4. Evaluate head loss in pipes and conduits.
5. Use dimensional analysis to design physical or numerical experiments and to apply dynamic similarity

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<td>Course Title</td>
<td>MANUFACTURING TECHNOLOGY</td>
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<td>Number of Credits</td>
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<td>Course Type</td>
<td>PROGRAMME CORE</td>
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</table>
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

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

Reference Books:


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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>MACHINE DRAWING</td>
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<td>Course Type</td>
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</table>

**Course Learning Objectives**

1. To understand and apply national and international standards while drawing machine component.
2. To understand the concept of various tolerances and fits used for component design
3. To familiarize in drawing assembly, orthographic and sectional views of various machine components.

**Course Content**


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.

Engine parts - Stuffing box, Connecting rod, Atomizer, spark plug, fuel injection pump. Valves - stop valve- safety valve, relief valve and non-return valve. Machine tool components - Drill jig, Tail stock,

Tool post, Tool head for shaping machine, machine vice, screw jack.

**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

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<tr>
<td>Course Title</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

Prerequisites: Basic Electrical and Electronics Engineering


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

Course Code : MEPC16
Course Title : THERMAL ENGINEERING
Number of Credits : 3
Prerequisites : MEPC11

Course Type : PROGRAMME CORE

Course Learning Objectives

1. To familiarize with the types of working principle of two stroke and four stroke engines.
2. To understand the various parameters involved in Engine combustion and its significance
3. To provide knowledge on various steam power equipment and its performance measurements
4. To impart skills to analyse Air Compressor system and components
5. To understand the concepts of waste heat recovery systems and thermal measurement devices.

Course Content


Compressors – Classification of compressors– Performance of reciprocating air compressor – Effect of clearance volume – Multi stage reciprocating air compressor – Optimum intermediate pressure for perfect inter cooling – Compressor mean effective pressure.


Psychrometric process-Air conditioning system – Working principles and concept of RSHF, GSHF, ESHF- Cooling Load calculations.

Reference Books:

Course Outcomes At the end of the course student will:
1. Apply principles of Air standard cycle to improve the engine performance and select suitable emission control methods for real time.
2. Perform tests on steam power thermal devices as per standards and interpret results.
3. Analyze the performance of Air compressor and select suitable intercooling system.
4. Appraise the refrigeration cycles and perform cooling load calculations for air-conditioning system.
5. Identify the suitable waste heat recovery methods for various thermal applications and analysis the energy losses using thermal measurement device.

Course Code : MEPC17
Course Title : MECHANICS OF MACHINES – I
Number of Credits : 3
Prerequisites (Course code) : MEPC10
Course Type : PROGRAMME CORE

Course Learning Objectives
1. To impart knowledge on various types of Mechanisms and synthesis
2. To impart skills to analyse the position, velocity and acceleration of mechanisms
3. 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

Introduction to animation software: working model

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

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

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
1. Synthesize and analyze 4 bar mechanisms
2. Use computers for mechanism animation and analysis
3. Understand cams and gears

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<thead>
<tr>
<th>Course Code</th>
<th>MEPC27</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>COMPUTER AIDED DESIGN AND DRAFTING</td>
</tr>
<tr>
<td>Number of Credits</td>
<td>3</td>
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<tr>
<td>Prerequisites</td>
<td>MEIR12</td>
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<td>(Course code)</td>
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<tr>
<td>Course Type</td>
<td>PROGRAMME CORE</td>
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</tbody>
</table>
**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.

<table>
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<tr>
<th>Course Code</th>
<th>MEPC20</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>ENGINEERING MATERIALS</td>
</tr>
<tr>
<td>Number of Credits</td>
<td>4</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>-NIL-</td>
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</tbody>
</table>

**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 various material testing methods.
Course Content


Phase Diagrams and Ferrous Alloys Fe- FeC diagram, Critical temperature - Plain carbon steel and other steels.


Testing of Materials I - Properties evaluated by tensile testing procedure, Engineering stress strain curve vs. true stress-strain curve, stress strain curve for typical materials. Hardness testing.

Testing of Materials II - Impact testing, Fracture toughness. Fatigue testing: Creep testing.

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

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 and predict the behavior of materials upon impact, fracture and creep testing.

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<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title : HEAT AND MASS TRANSFER</td>
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<td>Number of Credits : 3</td>
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<tr>
<td>Prerequisites (Course code) : MEPC11</td>
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<tr>
<td>Course Type : PROGRAMME CORE</td>
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</tbody>
</table>
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. Explain the real time applications of heat transfer in both solids and fluids.
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.
Course Code   : MEPC23
Course Title   : MECHANICS OF MACHINES – II
Number of Credits : 3
Prerequisites (Course Code) : MEPC17
Course Type   : PROGRAMME CORE

Course Learning Objectives

1. To impart knowledge about dynamic analysis of mechanisms and balancing
2. To familiarize about gyroscopes and flywheels
3. To give understanding various aspects of mechanical vibrations and their control

Course Content

Static and inertial force analysis of mechanisms. Balancing: rotating masses in single and several planes- reciprocating masses- single and multi-cylinder engines-Lanchester balancer

Gyroscopes: Gyroscopic effect- gyroscopes and their uses

Flywheel: industrial uses of flywheels- design of a flywheel of IC engines and punch press

Mechanical vibrations: linear and torsional vibrations- two rotor, three rotor and multi rotor systems- damped vibrations- 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 effect of vibration and vibration control
Course Code: MEPC24  
Course Title: ANALYSIS AND DESIGN OF MACHINE COMPONENTS  
Number of Credits: 3  
Prerequisites: MEPC12  

Course Learning Objectives

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

Course Content

Mechanical engineering design - Design considerations - Material selection - Modes of failure - Theories of failure - Endurance limit - Stress concentration - Factor of safety.  

Design of shafts and couplings - Design of cotter and knuckle joints.  

Helical and leaf springs.  

Fasteners and keys - Design of welded joints - Fillet and butt welds - Design of riveted joints.  

Design of sliding contact bearings - Selection of rolling contact bearings.

Reference Books:


Course Outcomes

At the end of the course student will  
1. Describe the design process, material selection, calculation of stresses and stress concentrations under variable loading.  
2. Design the solid, hollow shafts and to finding the critical speeds.  
3. Differentiate between rigid and flexible couplings and also the knuckle joints.  
4. Analyze bolted joints in eccentric loading.  
5. Examine the welded joints for vessels and steel structures also have a design knowledge on sliding and rolling contact bearing.  
6. Summarize the knowledge in helical, leaf, disc and torsional springs and also in levers.
## Course Learning Objectives

1. To discuss the generalized instrumentation system and calibration of instruments.
2. To describe the status and dynamic characteristics of instruments.
3. To analyze the error and uncertainty propagation of instruments.
4. To recall principles and analysis of measurement systems used for measurement of flow, power, pressure and temperature.
5. To explain the basics of control systems.

## Course Content


Static and dynamic characteristics of instruments zero order, first order, second order instruments.

Error analysis – Uncertainty propagation – Oscilloscope for analysis of dynamic and transient events.

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

Basics of control system – Types of control – proportional control, Derivative control, Integral control, PID control – Programmable Logic Controllers.

## Reference Books:


## Course Outcomes

At the end of the course student will be able to

1. To discuss the generalized instrumentation system and calibration of instruments
2. To describe static and dynamic characteristics of instruments
3. To analyze the error and uncertainty propagation of instruments
4. To recall principles and analysis of measurement systems used for measurement of flow, power, pressure and temperature
5. To explain the basics of control system.
Course Code : MEPC25  
Course Title : AUTOMOBILE ENGINEERING  
Number of Credits : 3  
Prerequisites : -NIL-  
Course Learning Objectives

1. To study basic and advanced automotive systems and subsystems.
2. To impart knowledge on the construction and principle of operation of in automotive engine and auxiliary systems.
3. To Understand the Vehicle Noise, Vibrations, Harshness, Comfort and Safety Systems.
4. To analyze the feasibility of alternate fuels / power source and emission control.

Course Content

Vehicle Structure, Comfort and Safety
Automobiles - Vehicle Construction - layouts, chassis, frame, body material and construction.  

Engine and Auxiliary Systems

Transmission Systems

Steering, Brakes and Suspension Systems
power assisted brakes. Factors affecting brake performance, Antilock Braking System (ABS) and traction control. Suspension - types, factors influencing ride comfort, shock absorbers. Wheels and Tyres – construction and materials. Static and rolling properties of pneumatic tyres, tubeless tyres, aspect ratio, tyre wear and maintenance.

Automotive Electrical and Electronics

Reference Books:
1990
2007.

Course Outcomes

At the end of the course student will be able to:
1. Identify the automobile structure, various systems and components, Noise, Vibrations, Harshness, comfort and safety systems.
2. Differentiate between the principles of SI and CI engines and command over the recent development in the area of alternate fuels for automotive engines.
3. Understand the transmission system and principles of clutch, gear box, Propeller shaft, differential, axle, wheels, tyres, steering, brake and suspension system.

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<tr>
<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>: DESIGN OF MECHANICAL DRIVES</td>
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<tr>
<td>Number of Credits</td>
<td>: 3</td>
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<tr>
<td>Prerequisites (Course code)</td>
<td>: MEPC12</td>
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<tr>
<td>Course Type</td>
<td>: PROGRAMME CORE</td>
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</tbody>
</table>
Course Learning Objectives

1. To teach students how to formulate the design and manufacturing problem for simple systems and mechanical components
2. To teach students how to apply the general mechanical engineering sciences in analyses specific to the design of mechanical components and systems
3. To teach students in a laboratory setting how to generate concepts, conduct analyses to size components, construct and assemble a prototype of a system and test its function
4. To reinforce students team skills through team projects, including problem formulation, problem solutions and written and oral reporting of results
5. To reinforce students visualization and hands-on skills through project virtual prototyping and / or physical construction exercises

Course Content

Friction drives: design of wheels, pressure devices, calculation of force of pressure, metallic and non-metallic wheels for strength with parallel and intersecting shafts.

Belt and rope drives: calculation-selection, service life.

Gear drives: types-criteria of calculation- design load, load concentration factor, dynamic load factor, teeth surface strength, allowable contact stresses, design for beam strength, allowable bending stresses, seizure prevention- main geometrical dimensions- design of precision gears.

Chain drives: process of load transmission, forces acting on chain, proportions of sprockets, and chains.

Reduction and variable speed drives: types- gear box design.

Reference Books:

3. Class materials.

Course Outcomes

At the end of the course student will
1. Recognize the need for friction drives and positive drives.
2. Apply BIS standards and catalogues in design and selection of belts and chain for requirement.
3. Select suitable drive combination based on requirement.
4. Explain failure modes in gears.
5. Establish suitability of a given drive elements whether to meet the requirement.

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<tr>
<th>Course Code</th>
<th>MEPC29</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>METROLOGY AND QUALITY CONTROL</td>
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<tr>
<td>Number of Credits</td>
<td>3</td>
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<tr>
<td>Prerequisites</td>
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<td>(Course code)</td>
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</table>
Course Learning Objectives

1. Describe the evolution of quality standards and metrology
2. Describe key points and timelines for the evolution of the quality system as we know it today
3. Define what a quality system is and why it is utilized, Identify and provide the uses for various quality tools such as check sheets, pareto charts, flowchart, cause and effect diagrams, histogram, scatter diagram and control charts

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/electronics 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 Equipments - Principles of measurement using Tool Maker’s microscope profile projector & 3D coordinate measuring machine.

Quality Control - Introduction, definition and concept of quality & quality control, set up policy and objectives of quality control, quality of design and quality of conformance, compromise between quality & cost, quality cost and planning for quality.

Sqc and Sqc Tools - Importance statistical methods in QC, measurement of statistical control variables and attributes, pie charts, bar charts/ histograms, scatter diagrams, pareto chart, GANT charts, control charts, X chart, X bar charts, R charts, P charts, np charts their preparation, analysis and applications. Elementary treatment on modern SQC tools. Sampling inspection and basic concepts, OC curves, consumer & producer risk, single & double sampling plans and use of sampling tables.

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. Apply statistical process control and acceptance sampling procedures in a manufacturing environment to improve quality of processes / products.
4. Identify suitable metrological methods for measuring the components.
5. Explain the acceptance test for machines.
6. Outline the working of various optical measuring instruments.

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<tr>
<th>Course Code</th>
<th>MEPC21</th>
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<tbody>
<tr>
<td>Course Title:</td>
<td>TURBOMACHINES</td>
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<tr>
<td>Number of Credits</td>
<td>3</td>
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<tr>
<td>Prerequisites (Course code)</td>
<td>MEPC18</td>
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<tr>
<td>Course Type</td>
<td>PROGRAMME CORE</td>
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</table>

Course Learning Objectives

The course is designed to introduce, through the law of Fluid Mechanics and Thermodynamics, the means by which the energy transfer is achieved in major types of turbomachines together with the differing behavior of individual types in operation. The course objectives are:

1. To introduce basic principles and equations governing the steady and unsteady compressible fluid flow associated with the turbomachineries.

2. To teach the design aspects of the turbomachinery parts and the methods to analyze the flow behavior, which depends on the geometric configuration of the turbomachines, as well as the machine produces or absorbs work will be introduced.

Course Content

**Fundamentals:** Classification, Applications of turbomachines, Performance parameters, Specific speed, Basic laws and equations, Velocity triangles.

**Hydraulic turbines:** Specific applications, types, construction, working and performance of various types of hydraulic turbines (Pelton, Francis, and Kaplan turbines), Cavitation in turbines and water hammer effects, Draft tube: Types, applications and performance analysis.

**Centrifugal pumps:** Theory, types, components, and working characteristics, Cavitation, NPSH, Priming, Axial flow pumps, Practical problems and remedies.

**Thermal turbines:** Steam turbine basic cycles, impulse and reaction turbines, Multistage turbines, Governing systems, Effects of reheating and regeneration, Application of Mollier diagram, Gas turbine basic cycle, Application of intercooling, reheating and regeneration, Introduction to wind turbines, Power and efficiency calculations.

**Air compressors:** Radial and axial compressors, Construction and performance analysis, Surging and stalling, Slip. Introduction to experimentations: Cascade analysis, Fluid flow measurements, Wind-tunnel techniques, Loss mechanisms in turbomachines.

**Reference Books:**

Course Outcomes

At the end of the course student will
The terminal objectives of the course is that, on successful completion of teaching-learning and evaluation activities, the students would be able to identify and analyze the various types of turbomachines and they can demonstrate a basic understanding of laws of compressible flow in association with the turbomachinery. In addition, they are equipped with the technical knowledge to design major components and do maintain turbomachines.

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>: POWER PLANT ENGINEERING</td>
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<tr>
<td>Number of Credits</td>
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<td>Prerequisites</td>
<td>(Course code) : MEPC21</td>
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<td>Course Type</td>
<td>: PROGRAMME CORE</td>
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</table>

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


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

**III. ELECTIVES**

a. PROGRAMME ELECTIVE (PE)

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<tr>
<th>Course Code</th>
<th>:</th>
<th>MEPE10</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>:</td>
<td>COMPRESSIBLE FLOW AND JET PROPULSION</td>
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<tr>
<td>Number of Credits</td>
<td>:</td>
<td>3</td>
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<tr>
<td>Prerequisites (Course code)</td>
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<td>Course Type</td>
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<td>PROGRAMME ELECTIVE</td>
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</table>

**Course Learning Objectives**

This course introduces the concepts of the primary differences between an incompressible flow and compressible flow. It draws the connection between compressible flow and speed of sound, Mach number and thermodynamics. The physical concept of shocks, and compressible fluid flows with effects of friction and heat transfer and the resulting changes in the thermodynamic properties of a fluid form a major part of this course. The course concentrates primarily on the understanding of the physical concepts of compressible flow and keeps reference to various numerical methods for solving the governing equations to a minimum. In addition, concepts of fluid flows in nozzles, diffusers and inlets of aircraft engines and the forces, moments, and loss generation resulting from compressible fluid flow interactions with aerodynamic shapes will be introduced.

**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 flow through variable area passage ducts - Flow through nozzles and diffusers, choked flow, critical pressure ratio, application of equation of critical pressure ratio, variation of Mach number with reference to cross sectional area.

**Flow with shocks:** Normal and oblique shocks, causes and effects of shocks, Prandtl-Meyer and Rankin-Hugoniot equation equations.

**Flow with effects of friction and heat transfer:** Fanno flow, isothermal fluid flow, Rayleigh flow, concepts of maximum length and its variation on subsonic and supersonic fluid entry.

**Jet Propulsion:** Fundamentals of jet propulsion - types of aircraft engines, propulsion cycle, power and efficiency calculations, turbojet, turbofan, and turboprop engines, basic concepts of rocket propulsion, engine types, construction and fuels

**References 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
The terminal objectives of the course is that, on successful completion of teaching-learning and evaluation activities, a student would be able to identify, appreciate and analyze the compressible fluid flow problems by applying the fundamental technologies of fluid mechanics in constant area & converging / diverging ducts, fluid flow with shocks, heat transfer and frictional effects.
In addition, they will be in a position to understand and discuss the mechanism of jet propulsion and engines of aircrafts and rockets.

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<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>COMPUTATIONAL FLUID DYNAMICS</td>
</tr>
<tr>
<td>Number of Credits</td>
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<tr>
<td>Prerequisites&lt;br&gt;(Course code)</td>
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<tr>
<td>Course Type</td>
<td>PROGRAMME ELECTIVE</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 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: FVM for 2-D unsteady state diffusion 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, solution procedures and turbulence modeling to solve flow and heat transfer problems.
4. Interpret the knowledge, capability of analyzing and solving any concept or problem associated with heat energy dynamics and utilization.
5. Illustrate the working concepts of thermal engineering devices.

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<tr>
<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>ADVANCED IC ENGINES</td>
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<tr>
<td>Number of Credits</td>
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<tr>
<td>Prerequisites</td>
<td>MEPC16</td>
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<tr>
<td>Course Type</td>
<td>PROGRAMME ELECTIVE</td>
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</table>

Course Learning Objectives

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

Course Content

Combustion process in SI and CI engines, Combustion chambers and abnormal combustion.

Composition and effect of Fossil and Alternative Fuels in IC Engine.

IC Engine Modelling – Zero dimensional, Two zone and Multi zone modelling

Instrumentation to study the combustion process in engines such as Particle image velocimetry, Holographic PIV, Spray visualization, Phase Doppler interferometry for spray characterization.

Pollutant formation in SI and CI engines and Control measures such as DOC, DPF, SCR, and LNT

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
1. Understand the combustion phenomena in SI and CI engines.
2. Study the characteristics of fossil and alternative fuels and their effect on the performance of IC engines.
3. Explain the recent technologies to tradeoff engine performance and emission characterization.
4. Explain the advanced imaging techniques to study the combustion and spray characteristics of the fuel.
5. Identify the exhaust pollutants and measurement techniques.

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<tbody>
<tr>
<td>Course Title</td>
<td>COMBUSTION ENGINEERING</td>
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<td>Number of Credits</td>
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<td>Prerequisites</td>
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**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**

Combustion of fuels - Combustion equations and air-fuel ratio calculations.

Thermodynamics of combustion - Thermochemistry - Kinetics of combustion.

Laminar and turbulent flames - Quenching, flammability, ignition and flame stabilization. Combustion in SI and CI engines.

Emission and control methods.

**Reference Books:**


Course Outcomes

At the end of the course student will
1. Formulate combustion equations to determine A/F, adiabatic flame temperature and pollutant concentration.
2. Relate the thermo chemistry and kinetics of combustion to evolve mathematical models for combustion.
3. Identify factors responsible for laminar and turbulent flame propagation.
4. Apply the different principles of flame stabilization and ignition to design combustor.
5. Summarize emission associated with combustion and identify their control techniques.

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<td>Course Title</td>
<td>BIOFUELS</td>
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<td>Prerequisites</td>
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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

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<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>REFRIGERATION AND AIR CONDITIONING</td>
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<td>Number of Credits</td>
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<td>Prerequisites (Course code)</td>
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</table>

**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 application.
4. To design and implement refrigeration and air conditioning systems using 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:


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.

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<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>FUNDAMENTALS OF HVAC SYSTEMS</td>
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<td>Number of Credits</td>
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<td>Prerequisites</td>
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</table>

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.

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<td>Course Title</td>
<td>: NANOTECHNOLOGY</td>
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<td>Prerequisites (Course code)</td>
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<td>Course Type</td>
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Course Learning Objectives
1. Understand how basic nanosystems 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.

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<td>Course Title</td>
<td>VEHICLE DYNAMICS</td>
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<td>Prerequisites</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.

Numerical Methods: Approximate methods for fundamental frequency, Dunker-Ley’s lower bound, Rayleigh’s upper bound-Holzer method for close-coupled systems and branched systems.

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;

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<td>Course Title</td>
<td>DYNAMICS OF MACHINERY</td>
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<td>Prerequisites</td>
<td>MEPC23</td>
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Course Type : PROGRAMME ELECTIVE

Course Learning Objectives

1. To understand the force-motion relationship in components subjected to External Forces
2. To analyse the force-motion characteristics of standard mechanisms
3. To study the undesirable effects of unbalances resulting from prescribed motions in mechanism.

Course Content

Single degree of freedom systems - Periodic excitations - Impulse response - Virtual work.

Forced vibrations.

Two degree of freedom systems - coupled vibrations.

Vibration of continuous systems.

Wave and Euler equations - Vibration of plates.

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 excited virtual work.
3. Examine the concept of forced vibration.
4. Extend the concept to two degree of freedom systems.
5. Manipulate the vibration of continuous systems.
6. Solve problems using wave and Euler equations.

Course Code : MEPE22
Course Title : MEMS DEVICES – DESIGN AND FABRICATION
Number of Credits : 3
Prerequisites : MEPC13
(Course code)

Course Learning Objectives

1. To think in an unified way about interdisciplinary Microsystems
2. Understand the operation of a wide range of sensors and actuators appropriate for microscale systems encompassing different energy domains represent microsystems as generalized networks.
3. To design, analysis and simulation master 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**

An overview of microelectromechanical devices and technologies, and an introduction to design and modeling.

Standard microelectronic fabrication technologies; bulk micromachining, surface micromachining, bonding technologies, related fabrication methods, and creating process flows.

Mechanical, thermal, electrical, magnetic, optical, and chemical properties of materials.

Introduction to lumped modeling of systems and transducers; an overview of system dynamics.

MEMS and NEMS examples, energy methods, the thermal energy domain; modeling dissipative processes,

Fluids and Transport.

**Reference Books:**


**Course Outcomes**

At the end of the course student will
1. Illustrate on the design and modeling of MEMS components.
2. Explain the various MEMS fabrication technologies.
3. Describe the mechanical, thermal, electrical, magnetic and chemical properties of materials.
4. Discuss the lumped modeling of systems and transducers.
5. Interpret the micro system dynamic.

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<td>Course Title</td>
<td>OIL HYDRAULICS AND PNEUMATICS</td>
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<td>Course Type</td>
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</table>
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.

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<th>Course Code</th>
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<td>Course Title</td>
<td>: INDUSTRIAL ROBOTICS</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


Robot Parts and Functions – Need for Robots – Different Applications, Principles and problems in robot design and control


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.

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<td>Course Title</td>
<td>MECHATRONICS</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.

**Text Books:**

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.

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<td>Course Title</td>
<td>INDUSTRIAL TRIBOLOGY</td>
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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

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<td>Course Title</td>
<td>: RENEWABLE ENERGY</td>
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<td>Prerequisites</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

Solar Energy

Wind Energy

Bio - Energy
Ocean and Geothermal Energy

New Energy Sources

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.

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<tr>
<td>Course Title</td>
<td>:  FINITE ELEMENT METHOD</td>
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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 using Finite Element technique

Course Content

Introduction - Illustration using spring systems and simple problems - Weighted residual methods
Galerkin's method - Variational approach - Rayleigh-Ritz method.

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.

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<td>Course Title</td>
<td>: COMPOSITE MATERIALS</td>
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| Course Type | : OPEN ELECTIVE |

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.

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<td>Course Title</td>
<td>: ADVANCES IN WELDING TECHNOLOGY</td>
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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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>MEOE14</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>INDUSTRIAL SAFETY ENGINEERING</td>
</tr>
<tr>
<td>Number of Credits</td>
<td>3</td>
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<tr>
<td>Prerequisites</td>
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<td>Course Type</td>
<td>OPEN ELECTIVE</td>
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</tbody>
</table>

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 – principles of accident prevention – accident investigation and analysis – records for accidents, departmental accident reports, documentation of accidents – unsafe act and condition – domino sequence – supervisory role – cost of accident.

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 fire fighting equipment – flammability limit- LPG safety - Hazard identification and Risk Analysis.

Overview of factories act 1948 – ISO-45001

Reference Books:


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 workplace and involve to take various control measures to prevent hazards.

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>: OPTIMIZATION IN ENGINEERING DESIGN</td>
</tr>
<tr>
<td>Number of Credits</td>
<td>: 3</td>
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<tr>
<td>Prerequisites (Course code)</td>
<td>: -NIL-</td>
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<tr>
<td>Course Type</td>
<td>: OPEN ELECTIVE</td>
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</tbody>
</table>
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.
3 Solve problems with single and multi – variable.
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.

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<tr>
<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>CRYOGENIC ENGINEERING</td>
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<td>Number of Credits</td>
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<td>Course Type</td>
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</tbody>
</table>

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 of classical thermodynamics to different cryogenic technologies, gas separation and purification system, and low power cryocoolers.
2. Understand the structures of different cryogenic systems and the analytical method for cryogenic thermodynamic cycle, and cryogenic gases and liquids and their mixtures.

Course Code : MEOE17
Course Title : ENERGY CONSERVATION AND MANAGEMENT
Number of Credits : 3
Prerequisites : NIL

Course Type : OPEN ELECTIVE

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


**References:**


**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

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>: ENERGY STORAGE TECHNOLOGY</td>
</tr>
<tr>
<td>Number of Credits</td>
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<td>(Course code)</td>
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<tr>
<td>Course Type</td>
<td>: OPEN ELECTIVE</td>
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</tbody>
</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 anlayse various types of energy storage devices and perform the selection based on techno-economic view point

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<tr>
<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>VEHICLE EMISSIONS AND CONTROL</td>
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<tr>
<td>Course Type</td>
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</tbody>
</table>
Course Learning Objectives

1. To introduce effect of air pollution on environment
2. To enable the students to understand the various pollutants.
3. To create confidence to evaluate vehicle pollution levels and measure them.

Course Content

Introduction to pollution, Chemical and thermal dynamics of combustion, Flames and engine combustion.
Atomization and sprays, Engine combustion: SI and CI Engines; Management of engines.
Formation of engine emission, N-O kinetics, Soot formation.
Emission measurement and standards; Control of emissions in SI and CI engines, exhaust after-treatment, NOx catalysts.
Alternative propulsion systems: HEV, FCV etc.; Engine fuel impacts on emissions, alternative fuels e.g., CNG, alcohols, biodiesel, hydrogen, GTL.

Reference Books:

Course Outcomes

At the end of the course student will
1. Measure the emission based on standards.
2. Apply their understanding on innovative methods to reduce pollution.
3. Interpret ways to control NOx emissions.

Course Code : MEMI10
Course Title : BASICS THERMODYANMICS
Number of Credits : 3
Prerequisites : -NIL-
Course Type : MINOR

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 – Dal ton’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.

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<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>FUNDAMENTALS OF THERMAL ENGINEERING</td>
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<tr>
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<td>Prerequisites (Course code)</td>
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<tr>
<td>Course Type</td>
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</tbody>
</table>
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
**Course Code**: MEMI12  
**Course Title**: FLUID MECHANICS AND MACHINERY  
**Number of Credits**: 3  
**Prerequisites**: -NIL-  
**Course Type**: MINOR

### 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
Course Code : MEMI13
Course Title : FUNDAMENTALS OF HEAT AND MASS TRANSFER
Number of Credits : 3
Prerequisites : -NIL-
(Course code)
Course Type : MINOR

Course objective

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.

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>MACHINE DESIGN</td>
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<tr>
<td>Number of Credits</td>
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Course Learning Objectives

1. The course will review the concepts of statics and strength of materials used to determine the stress, strain and deflection of one dimensional structures, stress in 2D, Plane stress and Strain.
2. Students will learn fundamental approaches to failure prevention for static and repeated loading.
3. Students will be given a thorough understanding of the design of common machine elements such as shafts, fasteners, joints, springs, bearings, and gears.

Course Content


Deflection and Stiffness – Deflection Due to Bending, Deflection Analysis, Compression, Elastic Stability.

Static and Fatigue Failures – Stress Concentration, Failure Theories for Ductile and Brittle Materials, Cyclic Stress, Fatigue Regimes - Combination of Loading Modes

Design of machine elements: Shafts and Shaft Components – Mechanical Springs - Screws, Fasteners and Rivets – Rolling Contact Bearings and Lubrication – Bearing Types, Selection of Bearings

Clutches, Brakes, and Flywheels, Flexible Mechanical Elements

Gears – Types of Gears - Force Analysis, Spur and Helical Gears.

Reference Books:

4. NPTEL :: Mechanical Engineering - Design of Machine Elements I

Course Outcomes

At the end of the course student will
At the end of the course student will be introduced to the stress, strain and deflection of simple mechanical elements and explore the concepts of safety factors of simple structures subjected to static and repeated loads, solve simple and open-ended design problems pertaining to basic machine elements like shafts, bearings, fasteners, springs, clutches, brakes and gears.

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<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>: FUNDAMENTALS OF AUTOMOTIVE TECHNOLOGY</td>
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<tr>
<td>Number of Credits</td>
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<td>Prerequisites</td>
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<td>Course Type</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

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<tr>
<td>Course Title</td>
<td>:</td>
<td>FUNDAMENTALS OF REFRIGERATION AND AIR CONDITIONING</td>
</tr>
<tr>
<td>Number of Credits</td>
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<tr>
<td>Prerequisites</td>
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<td>Course Type</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.
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.
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

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>ENGINE POLLUTION AND CONTROL</td>
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<tr>
<td>Number of Credits</td>
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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

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<tr>
<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>DYNAMICS</td>
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</table>

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.

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

Text Book:

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

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<td>Course Title</td>
<td>FUNDAMENTALS OF MECHANICAL DESIGN</td>
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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.

IV. ESSENTIAL PROGRAMME LABORATORY REQUIREMENT (ELR)

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<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
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<tr>
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<tr>
<td>Course Type</td>
<td>: ESSENTIAL PROGRAMME LABORATORY REQUIREMENT</td>
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</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 equipments for flow measurement.
3. Perform test on different fluid machinery.

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<tr>
<th>Course Code</th>
<th>MELR21</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>MANUFACTURING TECHNOLOGY LABORATORY</td>
</tr>
<tr>
<td>Number of Credits</td>
<td>2</td>
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<tr>
<td>Prerequisites</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

Lathe – Simple / Step / Taper Turning, Thread Cutting, Drilling and Boring.
Shaping – V – Cutting
Milling – Job requiring Indexing.
Hobbing – Spur Gear Cutting
Grinding – Surface / Cylindrical grinding
CNC Lathe – Simple Turing, Step Turning, Thread Turing
Machining Center – A typical job production.
Selective laser sintering and Fused Deposition Modelling – Modelling of a 3D part using
Solidworks/CATIA and tessellation of surfaces using MAGICS/MIMICS software for processing
in RP machine.
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

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<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>THERMAL ENGINEERING LABORATORY 1</td>
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<tr>
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<td>ESSENTIAL PROGRAMME LABORATORY REQUIREMENT</td>
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</tbody>
</table>

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.

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<tr>
<td>Course Title</td>
<td>:</td>
<td>COMPUTER AIDED DESIGN LABORATORY</td>
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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

Components drawing with dimensioning
Assembly drawing using modeling software package
Shaft coupling
Bearing
Automobile parts
Machine tool parts

Course Outcomes

At the end of the course student will be able to sketch, construct and simulate the mechanical engineering parts and components which include shaft coupling, bearings, automobile parts, machine tool parts along with their assembly drawing in a CAD package.

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<tr>
<td>Course Title</td>
<td>:</td>
<td>THERMAL ENGINEERING LABORATORY II</td>
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<td>:</td>
<td>ESSENTIAL PROGRAMME LABORATORY REQUIREMENT</td>
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</table>
Course Learning Objectives

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

Course Content

Study and performance tests on vapour compression refrigeration.
Study and performance tests on vapour absorption refrigeration.
Study and performance tests on air conditioning test rig.
Heat transfer experiments based on conduction and convection.
Heat transfer experiments based on radiation.
Experiments on heat exchangers.

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.

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<tr>
<th>Course Code</th>
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<td>Course Title</td>
<td>: DYNAMICS LABORATORY</td>
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<td>: ESSENTIAL PROGRAMME LABORATORY REQUIREMENT</td>
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</table>

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

Measurement of moment of inertia of rigid bodies.
Gyrooscope.
Linear vibration.
Torsional vibration.
Balancing.
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.

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<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>AUTOMOBILE ENGINEERING LABORATORY</td>
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<td>Number of Credits</td>
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<td>Prerequisites</td>
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**Course Code**

- **MELR16**

**Course Title**

- AUTOMOBILE ENGINEERING LABORATORY

**Number of Credits**

- 2

**Prerequisites**

- NIL

**Course Type**

- ESSENTIAL PROGRAMME LABORATORY REQUIREMENT

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**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
Course Code : MELR18
Course Title : METROLOGY AND QUALITY CONTROL LABORATORY
Number of Credits : 2
Prerequisites : -NIL-

Course Type : ESSENTIAL PROGRAMME LABORATORY REQUIREMENT

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.
V. ADVANCED LEVEL COURSES

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<tr>
<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>ADVANCED HEAT TRANSFER</td>
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<td>Course Type</td>
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Course Objectives

1. To use Heisler and Grober charts and to discuss about transient heat conduction
2. To compare and optimization of 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, radiation effect on temperature measurement.

Syllabus


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, Effect of non-condensable gases in condensing equipment – Pool and flow boiling correlations.


Course Outcome

At the end of the course student will
1. Discuss about transient heat conduction and to use Heisler and Grober charts
2. Analyze and optimize various fins like rectangular, triangular and parabolic profiles for heat transfer applications.
3. Understand thermal boundary layers, momentum and energy equations
4. Describe condensation and boiling heat transfer and estimate pool and flow boiling heat transfer
5. Analyze thermal and gas radiation in heat transfer equipment.

Reference Books


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<th>Course Code</th>
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<th>MEHO11</th>
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<tr>
<td>Course Title</td>
<td>:</td>
<td>ADVANCED FLUID MECHANICS</td>
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**Course Learning Objectives**

1. To familiarize with the properties of fluids and the applications of fluid mechanics.
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.

**Course Content**

Review of Basic concepts- Reynold’s transport theorem, Fluid kinematics –

Physical conservation laws - Integral and differential formulations. Navier-Stokes and energy equations - Dimensionless forms and dimensionless numbers - Solution of Navier-Stokes equations.

Two-dimensional Potential flows - Different types of flow patterns, complex potential conformal mapping.

Momentum integral approach. Turbulent flows - Reynolds equation and closure problems, free and wall bounded shear flows- Prandtl and von Karman hypothesis- Universal velocity profile near a wall- flow through pipes Boundary layer concept.

Boundary layer thickness- Prandtl’s equations - Blasius solution-skin friction coefficient.

**Reference Books:**

4. A first course in turbulence, Tennekesse and Lumley
5. Fluid mechanics, Kundu and Cohen

**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. Apply dimensional analysis to predict physical parameters that influence the flow in fluid mechanics.

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<th>Course Code</th>
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<tr>
<td>Course Title</td>
<td>SIMULATION OF IC ENGINES</td>
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**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

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<tr>
<td><strong>Course Title</strong></td>
<td>DESIGN AND ANALYSIS OF TURBOMACHINES</td>
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**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:**


**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.

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<th>Course Code</th>
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<td>Course Title</td>
<td>ADVANCED ENGINEERING MATERIALS</td>
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**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

**Course Content**

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

Bio-Materials, classes of materials used in medicine, application of materials in medicine and dentistry, various materials and coatings for implants. Composite materials, classifications, properties and applications.

Advanced materials - coatings and high-temperature materials

Thin film shape memory alloys for MEMS application
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

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<tr>
<td>Course Title</td>
<td>DESIGN OF HEAT EXCHANGERS</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

Design of surface and evaporative condensers –cooling tower – performance characteristics

Cryogenic heat exchangers – matrix heat exchangers, coiled tube 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

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<th>Course Code</th>
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<tbody>
<tr>
<td>Course Title</td>
<td>DESIGN AND OPTIMIZATION OF THERMAL ENERGY SYSTEMS</td>
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Course Learning Objective:

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.