MECHANICAL ENGINEERING

M.TECH (ENERGY TECHNOLOGY)

(CBCS)

REGULATIONS, CURRICULUM AND SYLLABUS

(With effect from the Academic Year 2011–12)

PONDICHERRY UNIVERSITY
PUDUCHERRY – 605 014
1.0 ELIGIBILITY

Candidates for admission to the first semester of four semester M.Tech (Energy Technology) should have passed B.E / B.Tech in Mechanical / Chemical Engineering / Aerospace / Aeronautical / Automobile / Energy Engineering / Marine Engineering/ and Petroleum Engineering through regular course of study from an AICTE approved institution or an examination of any University or authority accepted by the Pondicherry University as equivalent thereto, with at least 55% marks in the degree examination or equivalent CGPA.

Note:
1. Candidates belonging to SC/ST who have a mere pass in the qualifying examination are eligible.
2. There is no age limit for M.Tech. programmes.

2.0 ADMISSION

The admission policy for various M.Tech. programmes shall be decided by the respective institutes offering M.Tech. programmes subject to conforming to the relevant regulations of the Pondicherry University.

3.0 STRUCTURE OF PG PROGRAMME

3.1 GENERAL

3.1.1. The M.Tech. Programmes are of semester pattern with 16 weeks of instruction in a semester.

3.1.2 The programme of instruction for each stream of specialization will consist of:
   i. Core courses (compulsory)
   ii. Electives
   iii. Seminar
   iv. Directed study
   v. Project work

3.1.3 The M.Tech. Programmes may be of 4 semesters of duration.

3.1.4. Credits will be assigned to the courses based on the following general pattern:
i. One credit for each lecture period
ii. One credit for each tutorial period
iii. Two credits for each practical course
iv. Four credits for directed study
v. Twenty three credits for Project work divided into 9 credits for Phase-I and 14 credits for Phase – II.

One teaching period shall be of 60 minutes duration including 10 for discussion and movement.

3.1.5 Regulations, curriculum and syllabus of the M.Tech. programme shall have the approval of Board of Studies and other Boards/ Committees/ Councils, prescribed by the Pondicherry University. The curriculum has been so drawn up that the minimum number of credits and other requirements for the successful completion of the programme, in any stream, will be as given in Table 1.

**Table 1: Minimum credits and other Requirements**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Name of course and requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M Tech (Full Time)</td>
</tr>
<tr>
<td>1</td>
<td>No. of Semester</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Min. No. of credits of the programme</td>
<td>72</td>
</tr>
<tr>
<td>3</td>
<td>Max. No. of credits of the programme</td>
<td>75</td>
</tr>
<tr>
<td>4</td>
<td>Min. Cumulative Grade Point Average for pass</td>
<td>5</td>
</tr>
</tbody>
</table>
| 5       | Min. Successful credits needed for registering in the next semester | I-10  
                           |                              | II-25                           |
|         |                                                          | III-40                         |
| 6       | Min. period of completion of programme (continuous semesters) | 4                             |
| 7       | Max. period of completion of programme (continuous semesters) | 8                             |
| 8       | No. of core and Elective courses                         | 12                            |
| 9       | Laboratories                                             | 2                             |
| 10      | Directed study                                           | 1                             |
| 11      | Project work (Two semesters)                             | 2                             |

3.1.6 A core course is a course that a student admitted to a particular programme must complete successfully to receive the Degree. A student shall register in all the core courses listed in the curriculum of his/ her selected area of specialization. Core courses in a particular specialization are offered by the Department concerned.
3.1.7 Elective courses will have to be taken from the courses offered by the Departments in that particular semester from among the approved courses. A Core course of one Department may be taken as an Elective by a student from other Department.

3.1.8 Each student is required to make a seminar presentation on any chosen topic connected with the field of specialization. Preparation and presentation of a seminar is intended to investigate an in-depth review of literature, prepare a critical review and develop confidence to present the material by the student. The seminar shall be evaluated by a department committee constituted for this purpose, based on a report submitted by the candidate and a viva-voce conducted at the end of the semester.

3.1.9 Directed study is a theory course required to be credited by each student under the close supervision of a faculty member of the department. The title of the course and syllabus are to be formulated by the designated faculty member and approved by the vice-chairperson, taking into account the broad area in which the student can enrich his/her knowledge relevant to the area of specialization.

3.1.10 Project work is aimed at training the students to analyze independently any problem posed to them. The work may be analytical, experimental, design or a combination of these. The student can undertake the project work in the department concerned or in an industry/research laboratory approved by the Chairperson/Vice-Chairperson. The project report is expected to exhibit clarity of thought and expression. The evaluation of project work will be a continuous internal assessment based on two reviews, one internal viva-voce and an external viva-voce examination.

3.1.11 A student who has acquired the minimum number of total credits for the award of Degree/ Diploma will not be permitted to register for more courses for the purpose of improving his/her cumulative grade point average (see Table 1).

3.1.12 The medium of instruction, examination, seminars, thesis / dissertation/ project work will be in English.

3.2 GRADING

3.2.1 Based on the performance of each student in a semester letter grades will be awarded in each course at the end of the semester. The letter grades, the corresponding grade point and the description will be as shown in Table 2.

<table>
<thead>
<tr>
<th>GRADE</th>
<th>POINT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>10</td>
<td>EXCELLENT</td>
</tr>
<tr>
<td>A</td>
<td>9</td>
<td>VERY GOOD</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>GOOD</td>
</tr>
<tr>
<td>Grade</td>
<td>Mark</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>----------------------</td>
</tr>
<tr>
<td>C</td>
<td>7</td>
<td>ABOVE AVERAGE</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
<td>AVERAGE</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
<td>SATISFACTORY</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
<td>FAILURE</td>
</tr>
<tr>
<td>FA</td>
<td>0</td>
<td>FAILURE DUE TO LACK OF ATTENDANCE</td>
</tr>
</tbody>
</table>

3.2.2 A student is deemed to have completed a course successfully and earned the appropriate credit if and only if, he/she receive a grade of E and above. The student should obtain 40% of marks in end semester examination in a subject to earn a successful grade. A subject successfully completed cannot be repeated at any time.

3.2.3 The letter grades do not correspond to any fixed absolute mark. Each student is awarded a grade depending on his/her performance in relation to the performance of other students taking or has taken the course. For example, S does not mean he/she has secured 100% or 95%, but, rather that he/she is in the top 5% of all the students who have taken/are taking the course, in the judgment of the teachers. Grades shall be awarded based on the absolute marks in a meeting of the P.G. Programme Committee to be held not later than 10 days after the last day of semester examination. Normally not more than 5% of the students in any written/laboratory course shall be awarded the grade S and not more than one-third awarded A grade. Average marks in the class shall normally be C grade excepting in the case of practical/project where it may be B grade.

4.0 REGISTRATION

4.1 Each student, on admission, shall be assigned to a Faculty Advisor, who shall advise the student about the academic programme and counsel him/her on the choice of courses depending on his/her academic background and objective.

4.2 With the advice and consent of the Faculty Advisor, the student shall register for courses he/she plans to take for the semester before the commencement of classes. No student shall be permitted to register for courses exceeding 30 contact hours per week nor shall any student be permitted to register for any course without satisfactorily completing the prerequisites for the course, except with the permission of the concerned teacher in the prescribed format.

4.3 If the student feels that he/she has registered for more courses than he/she can handle, he/she shall have the option of dropping one or more of the courses he/she has registered for, with the consent of his/her Faculty Advisor, before the end of 3rd week of the semester. However, a student to retain his/her status should register for at least 10 credits/semester.

4.4 Students, other than those freshly admitted, shall register for the courses of their choice in the preceding semester by filling in the prescribed forms.

4.5 The College shall prescribe the maximum number of students in each course taking into account the physical facilities available.
4.6 The College shall make available to all students a bulletin, listing all the courses offered in every semester specifying the credits, the prerequisites, a brief description or list of topics the course intends to cover, the faculty who will be offering the course, the time and place of the classes for the course.

4.7 In any department, preference shall be given to those students for whom the course is a core-course, if, the demand for registration is beyond the maximum permitted number of students.

4.8 Normally no course shall be offered unless a minimum of 3 students are registered.

5.0 EVALUATION

5.1 Evaluation of theory courses shall be based on 40% continuous internal assessment and 60% end-semester examination. Evaluation of laboratory course shall be based on 50% internal assessment and 50% end-semester examination. In each course, there shall be a 3 hour end-semester examination.

5.2 The total marks for the project work will be 300 marks for Phase-I and 400 marks for Phase-II. The allotment of marks for external valuation and internal valuation shall be as follows:

**Project work – (Phase – I): 300 Marks**

<table>
<thead>
<tr>
<th>Internal valuation</th>
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<tbody>
<tr>
<td>Guide</td>
<td>50 marks</td>
</tr>
<tr>
<td>First Evaluation</td>
<td>50 marks</td>
</tr>
<tr>
<td>Second Evaluation</td>
<td>50 marks</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>150 marks</strong></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>External valuation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation (External Examiner Only)</td>
<td>50 marks</td>
</tr>
<tr>
<td>Viva voce (50 for Ext. + 50 for Int.)</td>
<td>100 marks</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>150 marks</strong></td>
</tr>
</tbody>
</table>
Project work – (Phase – II): 400 Marks

### Internal valuation

<table>
<thead>
<tr>
<th></th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guide</td>
<td>100</td>
</tr>
<tr>
<td>First Evaluation</td>
<td>50</td>
</tr>
<tr>
<td>Second Evaluation</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>200</strong></td>
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</tbody>
</table>

### External valuation

<table>
<thead>
<tr>
<th></th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation (External Examiner Only)</td>
<td>50</td>
</tr>
<tr>
<td>Viva voce (75 for Ext. + 75 for Int.)</td>
<td>150</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>200</strong></td>
</tr>
</tbody>
</table>

Internal evaluation shall be done by a committee comprising of not less than 3 faculty members appointed by the Vice-Chairperson.

5.3 The directed study shall be evaluated internally and continuously as detailed below:

- Test I : 15 Marks
- Test II : 15 Marks
- Assignment : 10 Marks
- Final test covering the whole syllabus : 60 Marks
- **Total** : 100 Marks

5.4 The end-semester examination as per the prescribed pattern shall be conducted by the department for all the courses offered by the department. Each teacher shall, in the 4th week of the semester submit to the Vice-Chairman, a model question paper for the end-semester examination. The end-semester question paper shall cover the entire syllabus of the course.

5.5 The department shall invite 2 or 3 external experts to be associated with the end-semester examinations and grading. Each expert will be asked to set the question papers for the courses he/she is competent to examine for the end-semester examination based on the model question paper submitted by the teacher concerned. The teacher and the concerned expert shall evaluate the answer scripts together and award the marks to the student. If, for any reason, no external expert is available for any paper, then, the teacher concerned shall set the question paper(s) for the end-semester examination, and the teacher himself shall evaluate the papers and award the marks.

5.6 In the Department, after the evaluation of all the end-semester examination papers, all the teachers who taught the courses and the external experts together shall meet with the P.G. Programme Committee (see section 7.0) and decide the cut-offs for grades in each of the courses and award the final grades to the students.
5.7 Continuous internal assessment mark of 40 for a theory course shall be based on two tests (15 marks each) and one assignment (10 marks) whereas internal assessment mark of 50 for a laboratory course shall be based on preparation of record (20 marks), mid-semester examination (20 marks) and internal viva voce (10 marks).

5.8 Every student shall have the right to scrutinize his / her answer scripts, assignments etc. and seek clarifications from the teacher regarding his/her evaluation of the scripts immediately after or within 3 days of receiving the evaluated scripts.

5.9 The Department shall send all records of evaluation, including internal assessment, for safe-keeping to the college administration, as soon as all the formalities are completed.

5.10 At the end of the semester each student shall be assigned a grade based on his her performance in each subject, in relation to the performance of other students.

5.11 A student getting F grade in a core course must repeat that course in order to obtain the Degree. A student getting F grade in an elective course may be permitted to choose another elective against the failed elective course, as the case may be, in consultation with the Faculty Adviser.

5.12 A student shall not be permitted to repeat any course or courses only for the purpose of improving the grade in particular course(s) or the cumulative grade point average (CGPA).

5.13 In exceptional cases, with the approval of the chairman, PG Programme committee, make-up examination(s) may be conducted for a student who misses an end-semester examination(s) due to extreme medical emergency, certified by the college Medical Officer, or due to clash in the end-semester examination between two courses which he/she has registered for, in that semester.

5.14 All eligible students should appear for end-semester examinations.

5.15 No student who has less than 75% attendance in any course shall be permitted to attend the end-semester examinations. However, a student who has percentage attendance between 60-75% in any course and absented on medical grounds has to pay a condonation fee of Rs.200/- for each course and produce a medical certificate from a Government Medical Officer not below the rank of R.M.O. or officer of equal grade to become eligible to appear for the examinations. A student with less than 60% attendance shall be given the grade of FA. He/She shall be asked to repeat that course if it is a core course, when it is offered the next time.

6.0 SUMMER TERM COURSE

6.1 A summer term course (STC) may be offered by the department concerned on the recommendations of P.G. Programme Committee. A summer term course is open
only to those students who had taken the course earlier and failed. No student shall be allowed to register for more than two courses during a summer term. Those students who had failed due to lack of attendance will not be allowed to register for the same course offered in summer, unless, certified by the concerned Vice-Chairman and the Principal.

6.2 Summer term course will be announced at the end of even semester. A student has to register within the time stipulated in the announcement by paying the prescribed fees.

6.3 The number of contact hours per week for any summer term course will be twice that of a regular semester course. The assessment procedure in a summer term course will be similar to the procedure for a regular semester course.

6.4 Withdrawal from a summer term course is not permitted.

7.0 PG PROGRAMME COMMITTEE

7.1 The M.Tech. Programme shall be monitored by a committee constituted for this purpose by the college. The committee shall consist of all teachers offering the courses for the programme and two student members or 10% of students enrolled whichever is less. The HOD or a senior faculty in the rank of a Professor shall be the vice-chairman nominated by the Head of the Institution. There shall be a common Chairman in the Rank of Professor nominated by the Head of the Institution. There can be a common coordinator in the rank of Professor nominated by the Head of the Institution.

7.2 It shall be the duty and responsibility of the committee to review periodically the progress of the courses in the programme, to discuss the problems concerning the curriculum and syllabi and conduct of classes. The committee may frame relevant rules for the conduct of evaluation.

7.3 The committee shall have the right to make suggestions to individual teachers on the assessment procedure to be followed in his/her course. It shall be open to the committee to bring to the notice of the Principal any difficulty encountered in the conduct of the classes or any other pertinent matter.

7.4 The committee shall meet at least twice in a semester: one at the beginning of the semester, and another at the end of the semester. In the last meeting the committee excluding the student members but with the external experts invited by the Chairman PG Programme Committee, shall finalize the grades of the students.

8.0 MINIMUM REQUIREMENTS

8.1 To be eligible to continue in the Programme a student must have earned a certain number of successful credits at the end of each semester as given in Table 1. If he/she fails to satisfy this criterion in any semester, he/she shall be placed on scholastic probation in the succeeding semester. If he/she fails to earn the number
of credits by the end of that year (including courses taken in summer), then, he/she shall be asked to discontinue the programme.

8.2 Students are expected to abide by all the rules of the college and maintain a decorous conduct. Any deviation will be referred to the Head of the Institution for necessary action.

8.3 No student who has any outstanding amount due to the college, Hostel, Library or Laboratory or against whom any disciplinary action is contemplated/ pending, will be eligible to receive his/her degree.

9.0 DECLARATION OF RESULTS AND ISSUE OF GRADE CARD

9.1 The PG Programme (CBCS) office shall display the grades as soon as possible after the finalization of the grades. The student shall have the right, for a look at the evaluated examination scripts and represent to the M.Tech Programme Committee for review if he/she feels aggrieved by the evaluation within one week from the commencement of succeeding semester classes.

9.2 The College shall issue at the beginning of each semester a grade card to the student containing grades obtained by the student in the previous semester (s) and his/her Grade Point Average (GPA) and his/her Cumulative Grade Point Average (CGPA).

9.3 The grade card shall list:
   a) title of the course(s) taken by the student
   b) credits associated with the course
   c) grade secured by the student
   d) total credits earned by the student in that semester
   e) GPA of the student
   f) total credits earned by the student till that semester and
   g) CGPA of the student

9.4 The GPA shall be calculated as the weighted average of the Grade Points weighted by the credit of the course as follows:

The product of the credit assigned to each course and the grade point associated with the grade obtained in the course is totaled over all the courses and the total is divided by the sum of credits of all the courses and rounded off to two decimal places.

For example, a student getting A in 4 credit course, B in 2 credit course, S in a 3 credit course and F in a 3 credit course, will have a GPA as: \((9 \times 4 + 8 \times 2 + 10 \times 3 + 0 \times 3) / (4+2+3+3)=82 /12=6.83/10.0.\)
The sum will cover all the courses the student has taken in that semester, including those in which he/she has secured F grade. Grades FA are to be excluded for calculating GPA and CGPA.

9.5 For computing CGPA, the procedure described in 9.4 is followed, except, that the sum is taken over all the courses the student has studied in all the semesters till then. If a student has repeated any course, the grade secured by him/her in the successful attempt only will be taken into account for calculating CGPA.

9.6 To convert CGPA into percentage marks, the following formula shall be used:

\[ \% \text{ Mark} = (\text{CGPA} - 0.5) \times 10 \]

9.7 A student who satisfies the course requirements for all semesters and passes all the examinations prescribed for all the four semesters within a maximum period of 10 semesters reckoned from the commencement of the first semester to which the candidate was admitted shall be declared to have qualified for the award of degree.

9.8 A student who qualifies for the award of degree shall be declared to have passed the examination in **First Class with Distinction** upon fulfilling the following requirements:

(i) He/she should have passed all the subjects pertaining to semesters 1 to 4 in his/her first appearance in 4 consecutive semesters starting from first semester to which the candidate was admitted.

(ii) He/she should not have been prevented from writing examinations due to lack of attendance.

(iii) He/she should have secured a CGPA of 8.50 and above for the semesters 1 to 4.

9.9 A student who qualifies for the award of the degree by passing all the subjects relating to semesters 1 to 4 within a maximum period of 6 consecutive semesters after his/her commencement of study in the first semester and in addition secures CGPA not less than 6.5 shall be declared to have passed the examination in **First Class**.

9.10 All other students who qualify for the award of degree shall be declared to have passed the examination in **Second Class**.

9.11 A student with CGPA less than 5.0 is not eligible for award of degree.

9.12 For the award of University rank and gold medal, the CGPA secured from 1st to 4th semester should be considered and it is mandatory that the student should have passed all the subjects from 1st to 4th semester in the first appearance and he/she should not have been prevented from writing the examination due to lack of attendance and should not have withdrawn from writing the end-semester examinations.
10.0 PROVISION FOR WITHDRAWAL

A student may, for valid reasons, and on the recommendation of the Vice-Chairperson and Chairperson be granted permission by the Head of the Institution to withdraw from writing the entire semester examination as one unit. The withdrawal application shall be valid only if it is made earlier than the commencement of the last theory examination pertaining to that semester. Withdrawal shall be permitted only once during the entire programme. Other conditions being satisfactory, students who withdraw are also eligible to be awarded DISTINCTION whereas they are not eligible to be awarded a rank/ gold medal.

11.0 TEMPORARY DISCONTINUATION FROM THE PROGRAMME

If a student wishes to temporarily discontinue the programme for valid reasons, he/she shall apply to the Chairperson, PG Programme committee, through the Head of the department in advance and secure a written permission to that effect. A student after temporary discontinuance may rejoin the programme only at the commencement of the semester at which he/she discontinued, provided he/she pays the prescribed fees. The total period of completion of the programme reckoned from the commencement of the first semester to which the candidate was admitted shall not in any case exceed 8 consecutive semesters including the period of discontinuance.

12.0 POWER TO MODIFY

12.1 Notwithstanding anything contained in the foregoing, the Pondicherry University shall have the power to issue directions/ orders to remove any difficulty.

12.2 Nothing in the foregoing may be construed as limiting the power of the Pondicherry University to amend, modify or repeal any or all of the above.

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# M.TECH (ENERGY TECHNOLOGY)

## CURRICULUM AND SCHEME OF EXAMINATION

(Total number of credits required for the completion of the programme: 72)

### SEMESTER – I

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credits</th>
<th>Evaluation (marks)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
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<td>ME 901</td>
<td>Energy conversion systems</td>
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<tr>
<td>2.</td>
<td>ME 902</td>
<td>Analysis of heat and mass transfer</td>
<td>3</td>
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<tr>
<td>3.</td>
<td>ME 903</td>
<td>Optimization techniques</td>
<td>3</td>
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<td>Elective – I</td>
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<tr>
<td>6.</td>
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<td>Elective – III</td>
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<td>7.</td>
<td>ME 907</td>
<td>Energy Engineering Laboratory</td>
<td>-</td>
<td>-</td>
<td>3</td>
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</tbody>
</table>

|         |        |                                           |              |        |        | Internal | External | Total |
| 1.      | ME 901 | Energy conversion systems                |              | 40    | 60    |          |          | 100   |
| 2.      | ME 902 | Analysis of heat and mass transfer       |              | 40    | 60    |          |          | 100   |
| 3.      | ME 903 | Optimization techniques                  |              | 40    | 60    |          |          | 100   |
| 4.      |        | Elective – I                             |              | 40    | 60    |          |          | 100   |
| 5.      |        | Elective – II                            |              | 40    | 60    |          |          | 100   |
| 6.      |        | Elective – III                           |              | 40    | 60    |          |          | 100   |
| 7.      | ME 907 | Energy Engineering Laboratory           |              | 100   | -     |          |          | 100   |

**Total:** 23 340 360 700

### SEMESTER – II

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Code</th>
<th>Subject</th>
<th>Hours / Week</th>
<th>Credits</th>
<th>Evaluation (marks)</th>
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<td></td>
<td></td>
<td>L</td>
<td>T</td>
<td>P</td>
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<tr>
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<td>ME 904</td>
<td>Thermodynamic analysis of energy systems</td>
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<td>2.</td>
<td>ME 905</td>
<td>Design of thermal equipment</td>
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<td>3.</td>
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<td>Elective – IV</td>
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<td>ME 908</td>
<td>Computational Techniques Laboratory</td>
<td>-</td>
<td>-</td>
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</table>

|         |        |                                           |              |        |        | Internal | External | Total |
| 1.      | ME 904 | Thermodynamic analysis of energy systems |              | 40    | 60    |          |          | 100   |
| 2.      | ME 905 | Design of thermal equipment               |              | 40    | 60    |          |          | 100   |
| 3.      | ME 906 | Computational fluid dynamics              |              | 40    | 60    |          |          | 100   |
| 4.      |        | Elective – IV                             |              | 40    | 60    |          |          | 100   |
| 5.      |        | Elective – V                              |              | 40    | 60    |          |          | 100   |
| 6.      |        | Elective – VI                             |              | 40    | 60    |          |          | 100   |
| 7.      | ME 908 | Computational Techniques Laboratory      |              | 50    | 50    |          |          | 100   |

**Total:** 23 290 410 700
# SEMESTER – III

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<th>Sl. No.</th>
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<th>Credits</th>
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# SEMESTER – IV

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## LIST OF ELECTIVES

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<thead>
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<th>Sl. No.</th>
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<tbody>
<tr>
<td>1.</td>
<td>ME 921</td>
<td>Advanced fluid mechanics</td>
</tr>
<tr>
<td>2.</td>
<td>ME 922</td>
<td>Advanced refrigeration and cryogenics</td>
</tr>
<tr>
<td>3.</td>
<td>ME 923</td>
<td>Alternate fuels and their applications</td>
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<tr>
<td>4.</td>
<td>ME 924</td>
<td>Biomass conversion systems</td>
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<td>5.</td>
<td>ME 925</td>
<td>Cogeneration Technology</td>
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<td>6.</td>
<td>ME 926</td>
<td>Energy conservation and management</td>
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<td>7.</td>
<td>ME 927</td>
<td>Energy conversion and environmental pollution</td>
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<td>8.</td>
<td>ME 928</td>
<td>Micro-Nano Scale Fluid Flow and Heat Transfer</td>
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<td>Hydrogen energy and fuel cells</td>
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<td>Modeling and simulation of energy systems</td>
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<td>11.</td>
<td>ME 931</td>
<td>Nuclear power engineering</td>
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<td>12.</td>
<td>ME 932</td>
<td>Power plant management and economics</td>
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<td>Thermal Turbomachines</td>
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<td>Solar power technology</td>
</tr>
<tr>
<td>15.</td>
<td>ME 935</td>
<td>Wind energy technology</td>
</tr>
</tbody>
</table>
Unit – I Energy sources


Unit – II Thermal energy conversion

Production of thermal energy using bio-mass, fossil fuels, nuclear fuels, solar energy – Conversion of thermal energy, electrical energy, electromagnetic energy and hydraulic energy into mechanical energy – Energy conversion system: steam turbines, hydraulic turbines and wind turbines – Energy conversion system cycles.

Unit – III Electrical energy generation


Unit – IV Non-conventional energy conversion systems

Production of electrical energy using non-conventional sources: solar energy, wind energy, wave energy, tidal energy and ocean thermal energy. Solar thermal energy conversion system – photovoltaic conversion – optical effects of p-n junction – analysis of PV cells – wave energy conversion system – tidal energy conversion system – wind energy conversion system.

Unit – V Energy storage


REFERENCE BOOKS:
ME 902 ANALYSIS OF HEAT AND MASS TRANSFER

Unit – I Conductive heat transfer


Unit – II Convective heat transfer


Unit – III Radiative heat transfer


Unit – IV Diffusive mass transfer


Unit – V Convective mass transfer

Significance of dimensionless parameters in convective mass transfer analysis – theories of boundary layers – governing differential equations – exact analysis of laminar boundary layer – approximate integral analysis of thermal boundary layer – mass, energy and momentum transfer analogies – models of convective mass transfer coefficients – inter-phase mass transfer – convective mass transfer correlations: mass transfer to plates, cylinders and spheres – mass transfer in wetted-wall columns, packed and fluidized beds – mass transfer involving turbulent flow through pipes.
REFERENCE BOOKS:
ME 903 OPTIMIZATION TECHNIQUES

Unit – I Basic Concepts


Unit – II Multivariable optimization

Simplex search method – Powell’s conjugate direction method – Conjugate gradient method – Variable-metric method.

Unit – III Constrained optimization


Unit – IV Special cases of optimization


Unit – V Specialized optimization algorithms

Genetic algorithms (GAs): working principle – difference between GAs and traditional methods – GAs for constrained optimization – Simulated annealing – Global optimization: using steepest descent method and GA.

REFERENCE BOOKS:
1. Deb, K., - Optimization for engineering design, Prentice Hall of India, 2005
ME 904 THERMODYNAMIC ANALYSIS OF ENERGY SYSTEMS

Unit – I Thermodynamic properties and relations

Thermodynamic properties: pressure, volume, temperature, specific heats, internal energy, enthalpy and entropy – Thermodynamic relations: Maxwell relations – Clausius Clapeyron equation – Joule-Thomson coefficient – Gibb’s function – Helmholtz function – Generalized relations for specific heats, internal energy, enthalpy and entropy.

Unit – II Evaluation of systems with first and second laws


Unit – III Elements of exergy analysis


Unit – IV Exergy analysis of thermal and chemical plants


Unit – V Thermodynamic optimization of thermal systems


REFERENCE BOOKS:

ME 905 DESIGN OF THERMAL EQUIPMENT

Unit – I Basic Concepts

Unit – II Conventional Heat Exchangers
Double pipe heat exchangers – applications and design parameters – types available. Shell and tube heat exchangers with single phase flow – design procedure – flow arrangement for increased heat recovery.

Unit – III Heat Exchangers with phase change
Types of condensers and their selection – design procedures – types of evaporators – shell and tube reboilers – types and thermal design.

Unit – IV Compact heat exchangers and regenerators

Unit – V Direct contact Heat Exchangers
Types of cooling towers – packing region – features of natural and mechanical draft towers – thermal performance of natural and forced draft cooling towers.

REFERENCE BOOKS:
   A. E. Bergles and F. Mayinger,
   A. E. Bergles Publishing Corporation, 1983
ME 906 COMPUTATIONAL FLUID DYNAMICS

Unit – I Introduction

Unit – II FDM

Unit – III FEM

Unit – IV Grid generation

Unit – V Specialized Techniques

REFERENCE BOOKS:
<table>
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<tr>
<th></th>
<th>Author(s)</th>
<th>Title</th>
<th>Publisher/Location</th>
<th>Year</th>
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<tr>
<td>7</td>
<td>Hoffmann, K. A.</td>
<td>Computational Fluid Dynamics for Engineers</td>
<td>Engineering Education system, Wichita, Kansas, USA</td>
<td>1993</td>
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<tr>
<td>11</td>
<td>Fletcher, J. H.</td>
<td>Computational Techniques for Fluid dynamics</td>
<td>Spring-Verlag, Berlin</td>
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ME 907 ENERGY ENGINEERING LABORATORY

1. Determination of heating/cooling load for the given space to be air-conditioned.
2. Performance test on Air Conditioning/Refrigeration system.
3. Aerodynamic study on Aerofoil and Cylinder (Pressure and Velocity distribution)
4. Energy balance test on given Steam Boiler.
5. Energy balance test on given Petrol engine.
7. Fuel and flue gas analysis using Gas – Chromograph.
ME 908 COMPUTATIONAL TECHNIQUES LABORATORY

(Programs are to be carried out using FORTRAN/ C languages)

1. Solution to linear algebraic equations using Gauss-Seidel method
2. Solution to linear algebraic equations using Conjugate Gradient method
3. Solution to linear algebraic equations using GMRES method
4. Solution to linear algebraic equations using LU decomposition method
5. Solution to nonlinear algebraic equations using Newton method
6. Determining Eigen value and Eigen vector for a system of equations
7. Finding roots of an equation using Newton-Raphson method
8. Solution to ODEs using Runge-Kutta method
9. Solution to ODEs through Finite Element method
10. Solution to Poisson’s equation with Dirichlet and Convective boundary conditions
11. Solution to 2D transient conduction equation using implicit method
12. Solution to one dimensional wave equation
13. Solution to 2D/3D problems using Fluent, Elmer, OpenFOAM etc.
ME 921 ADVANCED FLUID MECHANICS

Unit – I Kinematics and Kinetics


Unit – II Viscous fluid flow


Unit – III Laminar flow

Laminar boundary layer - laminar boundary layer equation – similarity solution for steady two dimensional flow – approximate integral method – numerical solutions - boundary layer control.

Unit – IV Turbulent flow


Unit – V Compressible fluid flow

Compressible flow - fundamental equation of flow of compressible viscous and inviscid fluid – plane couette flow – exact solution – steady flow through constant area pipe – laminar boundary layer equation in compressible flow – boundary layer with pressure gradient and with zero pressure gradient – application of moment integral equation to boundary layers – turbulent boundary layer equations in compressible flow – compressible turbulent flow past a flat plate.

REFERENCE BOOKS:
ME 922 ADVANCED REFRIGERATION AND CRYOGENICS

Unit – I Vapour compression refrigeration systems

Unit – II Vapour absorption and ejector refrigeration systems

Unit – III Cryogenics and liquefaction systems

Unit – IV Cryogenic refrigerators

Unit – V Cryogenic-fluid storage and transfer systems, instrumentation and applications
REFERENCE BOOKS:

4. Desrosier, N. W., - Technology of Food Preservation, AVT Publishing Co.,
ME 923 ALTERNATIVE FUELS AND THEIR APPLICATIONS

UNIT – I Overview

UNIT – II Vegetable oils and other similar fuels derived

UNIT – III Natural gas and LPG

UNIT – IV Hydrogen as alternative fuel

UNIT – V Biogas for IC engines

REFERENCE BOOKS:
ME 924 BIOMASS CONVERSION SYSTEMS

Unit – I Biomass definition, classification and properties

Unit – II Biomass combustion
Biomass combustion – biomass stoves, improved chullahs, types, some exotic designs – fixed bed combustors, types, inclined grate combustors – fluidized bed combustors – design, construction and operation of all the above biomass combustors – case studies.

Unit – III Biomass gasification
Biomass pyrolysis, types – manufacture of charcoal, yields and application – manufacture of pyrolytic oils and gases, yields and applications.

Unit – IV Bio-diesel
Non-edible vegetable oils – esterification, methods, yields, catalysts – bio-diesel – blends with diesel – use as engine fuel, combustion characteristics and performance of these fuels in engines, power output, efficiency and emissions – case studies.

Unit – V Biogas

REFERENCE BOOKS:
ME 925  COGENERATION TECHNOLOGY

Unit – I  Concepts

Unit – II  Performance
Thermodynamics of Cogeneration power plants – performance criteria and effect of irreversibility – Classification of Cogeneration Systems – Factors Influencing Cogeneration Choice

Unit – III Analysis

Unit – IV  Design
Design of Cogeneration plant for varying plant heat to power ratio – fuel savings from installation of cogeneration plant – Prime Movers for Cogeneration, Relative Merits of Cogeneration Systems

Unit – V  Alternatives

REFERENCE BOOKS:

2. David Hu, S., - Cogeneration, Reston Publishing Co., USA, 1985
Unit – I Concepts


Unit – II Thermal energy conservation


Unit – III Heat exchanger analysis


Unit – IV Energy conservation in industries

Energy conservation in industries - energy conservation in pumps, fans, compressed air systems, refrigeration & air conditioning systems, emergency DG sets, illumination, electrical motors – energy efficient motors and variable speed motors. Case studies for energy conservation in various industries such as cement, iron and steel, glass, fertilizer, food processing, refinery etc.

Unit – V Energy management


REFERENCE BOOKS:
2. Witte, Larry C., - Industrial energy management and utilization, Hemisphere publishers, Washington, 1988
5. Chiogioji, M. H., - Industrial Energy Conservation, Marcel Dekker, 1985
11. Tyagi, A. K., - Handbook of energy audits and management, TERI
12. PCRA Booklets.
ME 927 ENERGY CONVERSION AND ENVIRONMENTAL POLLUTION

Unit – I
Principal sources of energy: conventional and non-conventional sources - availability of energy sources, trade–off between energy and environment-green house effect- consequences of global warming – Pollution: indoor pollution-outdoor pollution-pollutants and their harmful effects on health and environment

Unit – II
Fuels used in thermal power plants – pollutants from thermal power plants -Gaseous emissions, particulate matter and smoke emissions – formation of pollutants – monitoring and analysis-flue gas analyzer -control techniques for different pollutants – Emission regulations – waste water treatment and disposal – ash handling system.

Unit – III
Pollution from automobiles-marine engines- diesel engine power plants – Pollutants from non-conventional fuels like natural gas, LPG, biogas, biodiesel, ethanol, methanol etc. – factors causing the formation of pollutants – control techniques-Emission regulations – Emission instrumentation: NO\textsubscript{x} analyzers, HC/CO analyzer, smoke analyzer-noise pollution

Unit – IV

Unit – V
Environmental Pollution from gas turbine power plants – Environmental Impact of renewable energy sources: Biomass energy – wind energy – OTEC – geothermal – tidal – solar photovoltaic energy conversion systems

REFERENCE BOOKS:
ME 928 MICRO-NANO SCALE FLUID FLOW AND HEAT TRANSFER

Unit – I
Introduction - Scaling issues in heat transfer and fluids, Derivation of governing equations of mass, momentum and energy, Fluid flow properties, Applications

Unit – II
Gas flows - Elements of kinetic theory of gases, Rarefied gas phenomena, Tangential momentum accommodation coefficient, solution in microchannel

Unit – III
Liquid flows - Introduction, Challenges in mixing at microscales, Electrokinetic effects Analysis

Unit – IV
Two-phase flows – Capillary effects, Gas bubbles, Droplet and Digital Microfluidics

Unit – V
Heat Transfer - Forced convection with slip, Thermal effects at microscales, Nanofluidics and Molecular dynamics, Direct simulation Monte-Carlo, Lattice Boltzmann method

REFERENCE BOOKS:

ME 929 HYDROGEN ENERGY AND FUEL CELLS

Unit – I Hydrogen Energy


Unit – II Hydrogen Energy Storage, Transportation and Applications


Unit – III Safety and environmental aspects of hydrogen


Unit – IV Fuel cells


Unit – V Fuel cell applications and economics


REFERENCE BOOKS:

ME 930 MODELLING AND SIMULATION OF ENERGY SYSTEMS

Unit – I


Unit – II


Unit – III


Unit – IV


Unit – V


REFERENCE BOOKS:

Unit – I

Unit – II

Unit – III

Unit – IV

Unit – V
Heat generation in reactors – thermal constraints – heat transfer to coolants – thermal design of reactor.

REFERENCE BOOKS:

ME 932 POWER PLANT MANAGEMENT AND ECONOMICS

Unit – I

Power Plant Economics and Tariffs: Load curve, load duration curve, different factors related to plants and consumers, Cost of electrical energy, depreciation, generation cost, effect of load factor on unit cost. Fixed and operating cost of different plants, role of load diversity in power system economy. Objectives and forms of Tariff: Causes and effects of low power factor, advantages of power factor improvement, different methods for power factor improvements.

Unit – II


Unit – III


Unit – IV

Organizational design of power plant – plant operation – quality control – maintenance schedule – log books – production records

Unit – V


REFERENCE BOOKS:

ME 933 THERMAL TURBOMACHINES

UNIT – I
Introduction to Thermal Turbomachines – Principle of operation – energy equation – classifications – work done, Losses and efficiencies – performance characteristics

UNIT – II
Flow through nozzles and diffusers – Steam turbines – impulse turbine and reaction turbines – velocity triangles – compounding – considerations in design of nuclear steam turbines – governing of steam turbines

UNIT – III

UNIT – IV

UNIT – V

REFERENCE BOOKS:
ME 934 SOLAR POWER TECHNOLOGY

Unit – I
Solar energy, geometry, solar radiation – availability, measurement and estimation – solar tracking – Isotropic and anisotropic models – empirical relations

Unit – II

Unit – III
Solar thermal energy storage – sensible heat storage - latent heat storage- Thermo chemical storage - water, packed bed storages – storage in phase change materials, performance and analysis.

Unit – IV

Unit – V

REFERENCE BOOKS:

ME 935 WIND ENERGY TECHNOLOGY

Unit – I Wind resource

Unit – II Principle of Wind Energy Conversion

Unit – III Performance of Wind turbines, loading estimation

Unit – IV Design of wind turbines and control, safety and electrical systems

Unit – V Wind turbine plant installation and economics

REFERENCE BOOKS:
ME 961      DIRECTED STUDY

Each candidate is required to make a study on a relevant topic connected with the field of specialization. The topic shall be chosen in consultation with the concerned Faculty Guide and Head of the Department. It would be such as to develop investigative and creative ability of the candidate. A presentation shall be given after a thorough investigation of the literature and other data relevant to the topic.
ME 909 MAJOR PROJECT (PHASE – I)

The project work is to acquaint the student in the analysis of problems posed to him, in the method of conducting a detailed literature survey and reviewing the state of art in the area of the problem. If the major project (Phase–I) which is not purely theoretical, student is also expected to design, conduct and develop skills of experimental work, in some of them and to analyse the results obtained. An Internal Examiner will examine the project report written at a viva-voce.

ME 910 MAJOR PROJECT (PHASE – II)

The student will take up the Major Project (Phase–II) in the fourth semester. This is aimed at exposing the students to analyze independently his project work. The work may be purely analytical or completely experimental or combination of both. In few cases, the project can also involve a sophisticated design work. The major project report is expected to show clarity of thought and expression, critical appreciation of the existing literature and analytical and/or experimental or design skill. The dissertation work should be of relevant nature for the current and the future needs of the country. The dissertation report will be examined at the time of viva-voce.
INFRASTRUCTURE AND FACULTY REQUIREMENT FOR M.TECH (PRODUCT DESIGN AND MANUFACTURING)

1. INFRASTRUCTURE:

(i) Building Infrastructure

<table>
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<td>3.</td>
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(ii) Equipment Infrastructure

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<td>Gas – Chromograph</td>
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<td>2.</td>
<td>Proximate analysis of solid fuel.</td>
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<tr>
<td>3.</td>
<td>Bomb Calorimeter</td>
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<td>Emission Testing using Combustion Gas Analyser</td>
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<td>Steam Boiler</td>
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<td>7.</td>
<td>Solar radiation – measurement and analysis.</td>
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2. LIBRARY:

Number of books : 100
Titles : As required by the curriculum
Journals : 5 related International journals
3. FACULTY REQUIREMENT:

<table>
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<tr>
<td>2.</td>
<td>Associate Professor</td>
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<td>3.</td>
<td>Assistant Professor</td>
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4. TEACHER TO STUDENT RATION : 1:15

5. STUDENT TO COMPUTER RATIO : 1:1