Academic Regulations

Course Structure & Detailed Syllabus

CHOICE BASED CREDIT SYSTEM

R25

Master of Technology (M.Tech)

THERMAL ENGINEERING

For the batches admitted from the A.Y. 2025-26

MARRI LAXMAN REDDY
GROUP OF INSTITUTIONS

MLR Institute of Technology

(Autonomous)
Laxman Reddy Avenue, Dundigal
Hyderabad – 500043, Telangana State
www.mlrit.ac.in, Email: director@mlrinstitutions.ac.in

M.Tech in Thermal Engineering

VISION

- The Mechanical Engineering Department endeavors to be recognized globally for outstanding education and research leading to well qualified engineers, who are innovative, entrepreneurial and successful in advanced fields of mechanical engineering to cater the ever changing industrial demands and social needs.

MISSION

- Impart highest quality education to the students to build their capacity and enhancing their skills to make them globally competitive mechanical engineers and successful entrepreneurs.
- Provide the students with academic environment of excellence, state of the art research facilities, leadership, ethical guidelines and lifelong learning needed for a long productive career.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO1: To inculcate qualities for long term learning with ethical and societal responsibilities.

PEO2: To adapt students on sustainability and conservation of resources.

PEO3: To expose the students to current global scenario on cutting edge technologies related to Thermal Engineering.

PROGRAM OUTCOMES (POs):

Engineering Graduates will be able to:

PO1. An ability to independently carry out research / investigation and development work to solve practical problems.

PO2. An ability to write and present a substantial technical report/document.

PO3. Students should be able to demonstrate a degree of mastery over the areas per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1. To train students with in-depth and advanced knowledge to become professionals in the areas of thermal sciences and related fields capable of identifying, analyzing and solving complex problems.

PSO2. To enable graduates to carry out innovative and independent research work in academia/industry to develop thermal systems and processes and to disseminate the knowledge

Academic Regulations, Course Structure & Detailed Syllabus

CHOICE BASED CREDIT SYSTEM

R25

DEPARTMENT OF MECHANICAL ENGINEERING

FOR

Master of Technology (M.Tech.)

Thermal Engineering

M. Tech. - Regular Two Year Degree Program

(For batches admitted from the academic year 2025 - 2026)

MARRI LAXMAN REDDY GROUP OF INSTITUTIONS

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ACADEMIC REGULATIONS
R25

Master of Technology (M.Tech)

M.Tech. - Regular Two Year Degree Programme
(For batches admitted from the academic year 2025-2026)

MARRI LAXMAN REDDY

MLR Institute of Technology

(Autonomous)

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ACADEMIC REGULATIONS (R25)
M. Tech. - Regular Two Year Degree Programme
(For batches admitted from the academic year 2025-26)

Academic Regulations of M.Tech (Regular/Full Time) Programmes, 2025-26 (R-25)
(Effective for the students admitted from the Academic Year 2025-26 and onwards)

1.0 MLR Institute of Technology(MLRIT) offers **Two** Years (**Four** Semesters) full-time Master of Technology (M.Tech.) Degree programmes, under Choice Based Credit System (CBCS) at its non-autonomous affiliated colleges in different branches of Engineering and Technology with different specializations.

All the rules specified herein approved by the Academic Council will be in force and applicable to students admitted from the Academic Year 2025-26 onwards. Any reference to "Institute" or "College" in these rules and regulations shall stand for MLR Institute of Technology (Autonomous).

All the rules and regulations, specified hereafter shall be read as a whole for the purpose of interpretation as and when a doubt arises, the interpretation of the Chairman, Academic Council is final. As per the requirements of statutory bodies, the Principal, MLR Institute of Technology shall be the chairman Academic Council.

2.0 Eligibility for Admissions

2.1 Admission to the M.Tech. programme shall be made subject to eligibility, qualification and specializations prescribed by the University from time to time, for each specialization under each M.Tech. programme.

2.2 Admission to the post graduate programme shall be made on the basis of either the merit rank or Percentile obtained by the qualified student in the GATE Examination/ the merit rank obtained by the qualified student in an entrance test conducted by Telangana Government (TG PGECET) for M.Tech. programmes/ an entrance test conducted by JNTUH/TGCHE on the basis of any other exams approved by the University, subject to reservations as laid down by the Govt. from time to time.

2.3 The medium of instructions for all PG Programmes will be **ENGLISH** only.

3.0 M.Tech. Programme Structure

3.1 The M.Tech. Programs of MLRIT are of Semester pattern, consisting of **Two** academic years, each academic year having **Two** Semesters (Odd and Even Semesters).

3.2 The two-year M. Tech. program consists of **68** credits and the student has to register for all **68** credits and earn all **68** credits for the award of M. Tech. degree.

3.3 The student shall not take more than four academic years to fulfill all the academic requirements for the award of M. Tech. degree from the date of commencement of first year first semester, failing which the student shall forfeit the seat in M. Tech. programme.

3.4 **UGC/AICTE** specified definitions/descriptions are adopted appropriately for various terms and abbreviations used in these PG academic regulations, as listed below:

3.4.1 Semester Scheme

There shall be a minimum of 15 weeks of instruction, excluding the mid-term and semester-end exams. Around 15 instruction hours, 30 instruction hours and 45 hours of learning need to be followed per one credit of theory course, practical course and project/field-based learning respectively. In each semester, there shall be 'Continuous Internal Evaluation (CIE)' and 'Semester End Examination (SEE)' under Choice Based Credit System (CBCS). The curriculum/course structure suggested by AICTE is followed as a reference document.

3.4.2 Credit Courses

All courses are to be registered by the student in a semester to earn credits which shall be assigned to each course in an L: T: P: C (Lecture Periods: Tutorial Periods: Practical Periods: Credits) structure based on the following general pattern:

- One credit for one hour/week/semester for theory/lecture (L) courses or tutorials (T)
- One credit for two hours/ week/semester for laboratory/ practical (P) courses
- One credit is allocated for three hours per week in a semester for Project/Mini-Project session.

3.4.3 Course Classification

All courses offered for the Post-Graduate M.Tech. Degree program are broadly classified as follows. The University has followed in general the guidelines issued by AICTE/UGC.

S. No.	Broad Course Classification	Course Group/ Category	Course Description
1	Core Courses (CoC)	PC- Professional Core	Includes courses related to the parent discipline/department/ branch of Engineering
		Dissertation	M. Tech. Project or PG Project or Major Project
		Mini Project with Seminar	Seminar based on core contents related to Parent Discipline/ Department/ Branch of Engineering
2	Elective Courses (EıE)	PE - Professional Electives	Includes elective courses related to the parent discipline/department/branch of Engineering
		OE - Open Electives	Elective courses which include inter-disciplinary courses or courses in an area outside the parent discipline/department/ branch of Engineering
3	Audit Courses	--	Non-Credit Audit Courses

4.0 Course Registration

4.1 A Faculty Advisor or Counselor shall be assigned to each specialization, who will advise on the Post Graduate Programme, its Course Structure and Curriculum, Choices/Options for Courses, based on his competence, progress, pre-requisites and interest.

4.2 The on-line Registration Requests for any current semester shall be completed before the commencement of SEEs (Semester End Examinations) of the preceding semester.

4.3 A Student can apply for on-line Registration, only after obtaining the written approval from his Faculty Advisor, which should be submitted to the College Academic Section through the Head of Department (a copy of it being retained with Head of Department, Faculty Advisor and the Student).

4.4 If the Student submits ambiguous choices or multiple options or erroneous entries during on-line Registration for the Course(s) under a given/ specified Course Group/ Category as listed in the Course Structure, only the first mentioned Course in that Category will be taken into consideration.

4.5 Course Options exercised through on-line Registration are final and cannot be changed. further, alternate choices will not be considered. However, if the Course that has already been listed for Registration by the University in a Semester could not be offered due to unforeseen or unexpected reasons, then the Student will be allowed to have alternate choice either for a new Course, if it is offered, or for another existing Course (subject to availability of seats). Such alternate arrangements will be made by the Head of Department, with due notification and time-framed schedule, within the first week from the commencement of Class-work for that Semester.

5.0 Attendance Requirements

Attendance is calculated separately for each course.

5.1 Attendance in all classes (Lectures/Laboratories) is compulsory. The minimum required attendance in each theory course (***also Audit Courses***) including the attendance of mid-term examination / Laboratory etc. is

75%. Two periods of attendance for each theory course shall be considered, if the student appearsfor the mid-term examination of that course. ***This attendance should also be included in the attendance uploaded every fortnight in the University Website. The attendance of Audit Courses should be uploaded separately to the University.*** A student shall not be permitted to appear for the Semester End Examinations (SEE), if his attendance is less than 75%.

5.2 A student's Seminar report and presentation on Mini Project shall be eligible for evaluation, only if he ensures a minimum of 75% of his attendance in Seminar presentation classes on Mini Project during that Semester.

5.3 **Condoning of shortage of attendance** up to a maximum of 10% (considering the days of attendance in sports, games, NCC, NSS activities and Medical grounds) in each course (Theory/Lab/Mini Project with Seminar) of a semester shall be granted by the College Academic Committee on genuine reasons.

5.4 A prescribed fee per course shall be payable for condoning shortage of attendance after getting the approval of College Academic Committee for the same. The College Academic Committee shall maintain relevant documents along with the request from the student.

5.5 Shortage of Attendance below 65% in any course shall in **no case be condoned.**

5.6 A Student, whose shortage of attendance is not condoned in any course(s) (Theory/Lab/Mini Project with Seminar) in any Semester, is considered as 'Detained in that course(s), and is not eligible to write Semester End Examination(s) of such course(s), in that Semester; and he/she has to seek re-registration for those course(s) in subsequent Semesters, and attend the same as and when offered.

5.7 A student fulfills the attendance requirement in the present semester, shall not be eligible for readmission into the same class.

5.8 **a)** A student shall put in a minimum required attendance in at least three theory courses (excluding Audit course) in first Year I semester for promotion to first Year II Semester.

b) A student shall put in a minimum required attendance in at least three theory courses (excluding *Audit* course**)** in first Year II semester for promotion to second Year I Semester.

6.0 Academic Requirements

The following academic requirements must be satisfied, in addition to the attendance requirements mentioned in clause no. 5. The performance of the candidate in each semester shall be evaluated course-wise, with a maximum of 100 marks per course (theory / practical), based on Continuous Internal Evaluation and Semester End Examination.

6.1 A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course, if he secures not less than:

- 40% of Marks (24 out of 60 marks) in the Semester End Examination;
- A minimum of 50% of marks in the sum total of CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together; in terms of Letter Grades this implies securing **'B'** Grade or above in a course.

6.2 A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to Mini Project with seminar, if student secures not less than 50% marks (i.e. 50 out of 100 allotted marks). The student would be treated as failed, if student (i) does not submit a seminar report on Mini Project or does not make a presentation of the same before the evaluation committee as per schedule or (ii) secures less than 50% marks in Mini Project with seminar evaluation. The failed student shall reappear for the above evaluation when the notification for supplementary examination is issued.

6.3 A student shall register for all courses for total of **68** credits as specified and listed in the course structure for the chosen specialization, put in the required attendance and fulfill the academicrequirements for securing **68** credits obtaining a minimum of **'B'** Grade or above in each course, and shall ***pass all the Audit Courses*** to complete the M.Tech. Programme successfully.

Note: (1) The SGPA will be computed and printed on the marks memo only if the candidate passes in

all the courses offered and gets minimum B grade in all the courses.

(2) CGPA is calculated only when the candidate passes in all the courses offered in all the semesters

6.4 Letter Grades obtained in all those courses covering the above specified **68** credits alone shall be considered for the calculation of final CGPA, which will be indicated in the consolidated grade memo.

6.5 When a student is detained due to shortage of attendance in any course(s) in any semester, shall not be permitted to write the Semester End Examinations. However, he is eligible for re-registration of such course(s) in the subsequent semester(s), as and when next offered, with the academic regulations of the batch into which he is re-registered, by paying the prescribed fees per course. In all these re-registration cases, the student shall have to secure a fresh set of internal marks and Semester End Examination marks for performance evaluation in such course(s), and SGPA/CGPA calculations.

6.6 A student eligible to appear for the Semester End Examination in any course, but absent from it or failed (failing to secure 'B' Grade or above), may reappear for that course at the supplementary examination as and when conducted. In such cases, his Internal Marks assessed earlier for that course will be carried over, and added to the marks secured in the supplementary semester end examination, for the purpose of evaluating his performance in that course.

6.7 A Student who fails to earn **68** credits as per the specified course structure, and as indicated above, within **four** academic years from the date of commencement of his first year first semester, shall forfeit his seat in M. Tech. programme and his admission **shall stand cancelled.**

7.0 Evaluation - Distribution and Weightage of Marks

The performance of a student in each semester shall be evaluated course- wise (irrespective of credits assigned) for a maximum of 100 marks.

7.1 The performance of a student in every course (including practicals and Project) will be evaluated for 100 marks each, with 40 marks allotted for CIE (Continuous Internal Evaluation) and 60 marks for SEE (Semester End-Examination). The Continuous Internal Evaluation for theory courses shall be made based on the average of the marks secured in the two Mid-Term Examinations conducted, first Mid- Term examinations in the middle of the Semester and second Mid-Term examinations during the last week of instruction.

7.2 In CIE, for theory courses, during a semester, there shall be two mid-term examinations. Each Mid-Term examination consists of two parts i) **Part – A** for 10 marks, ii) **Part – B** for 20 marks with a total duration of two hours as follows:

1. Mid-Term Examination for 30 marks:
   a. Part - A: Objective/quiz paper for 10 marks.
   b. Part – B: Descriptive paper for 20 marks.

The objective/quiz paper is set with multiple choice, fill-in the blanks and match the following type of questions for a total of 10 marks. The descriptive paper shall contain 6 full questions out of which, the student has to answer 4 questions, each carrying 5 marks. The average of the two Mid Term Examinations shall be taken as the final marks for Mid Term Examination for 30 marks.

The remaining 10 marks of Continuous Internal Assessment (out of 40) are distributed as:

2. 5 marks for Assignment. (Average of 2 Assignments each for 5 marks)
3. Course Viva-Voce/PPT/Poster Presentation/ Case Study on a topic in the concerned course for 5 marks.

While the first mid-term examination shall be conducted on 50% of the syllabus, the second mid-term examination shall be conducted on the remaining 50% of the syllabus.

Five (5) marks are allocated for assignments (as specified by the course teacher concerned). The first assignment should be submitted before the conduct of the first mid-term examination, and the second

assignment should be submitted before the conduct of the second mid-term examination. The average of the two assignments shall be taken as the final marks for assignment.

Course Viva-Voce/PPT/Poster Presentation/ Case Study on a topic in the concerned course for five marks before II Mid-Term Examination.

The details of the end semester question paper pattern are explained in the next clause:

7.3 The Semester End Examinations (SEE), for theory courses, will be conducted for 60 marks consisting of two parts viz. i) **Part- A** for 10 marks, ii) **Part - B** for 50 marks.

- Part-A is a compulsory question which consists of ten sub-questions with uniform coverage from all units carrying equal marks.
- Part-B consists of five questions (numbered from 2 to 6) carrying 10 marks each. Each of these questions is from each unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.
- The duration of Semester End Examination is three hours.

7.4 For practical courses there shall be a Continuous Internal Evaluation (CIE) during the semester for 40 marks and 60 marks for semester end examination. Out of the 40 marks for internal evaluation:

1. A write-up on day-to-day experiment in the laboratory (in terms of aim, components/procedure, expected outcome) which shall be evaluated for 10 marks
2. 10 marks for viva-voce (or) tutorial (or) case study (or) application (or) poster presentation of the course concerned.
3. Internal practical examination conducted by the laboratory teacher concerned shall be evaluated for 10 marks.

   4. The remaining 10 marks are for Laboratory Project, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

In the Semester End Examination, held for three hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

- The Student, in each course, shall have to earn 40% of marks (i.e. 16 marks out of 40 marks) in CIE, 40% of marks (i.e. 24 marks out of 60) in SEE and Overall 50% of marks (i.e. 50 marks out of 100 marks) both CIE and SEE marks taking together.

The student is eligible to write Semester End Examination of the concerned course, if the student scores ≥ 40% (16 marks) of 40 Continuous Internal Examination (CIE) marks.

In case, the student appears for Semester End Examination (SEE) of the concerned course but not scored minimum 40% of CIE marks (16 marks out of 40 internal marks), his performance in that course in SEE shall stand cancelled inspite of appearing the SEE.

7.5 For conducting laboratory end examinations of all PG Programmes, one internal examiner and one external examiner are to be appointed by the Principal of the College and this is to be informed to the Director of University Examinations within two weeks, before commencement of the lab end examinations. The external examiner should be selected from outside the College concerned but within

the cluster. No external examiner should be appointed from any other College in the same cluster/any other cluster which is run by the same Management.

7.6 There shall be Mini Project with Seminar during I year II semester for internal evaluation of 100 marks. The Departmental Academic Committee (DAC) will review the progress of the mini project during the seminar presentations and evaluate the same for 50 marks. Mini Project Viva Voce will be evaluated by the DAC for another 50 marks before the semester end examinations. Student shall carryout the mini project in consultation with the mini project supervisor which may include critically reviewing the literature, project implementation and submit it to the department in the form of a report and shall make an oral presentation before the DAC consisting of Head of the Department, Mini Project supervisor and two other senior faculty members of the department. The student has to secure a minimum of 50% of marks in i) seminar presentation and ii) mini project viva voce, to be declared successful. If he fails to obtain the minimum marks, he has to reappear for the same as and when scheduled.

7.7 Every candidate shall be required to submit a dissertation on a topic approved by the Dissertation Review Committee.

7.8 The M.Tech. Dissertation shall be prepared in the structure prescribed by the University, adhering to the style files and formatting guidelines. To facilitate this process, each institution will organize a brief orientation session for the entire class/section at the beginning of the final semester, guiding the students on the required structure and formatting of the dissertation.

7.9 A Dissertation Review Committee (DRC) shall be constituted with the Head of the Department as Chairperson, Dissertation Supervisor and one senior faculty member of the Department offering the M.Tech. programme.

7.10 Registration of Dissertation Work: A candidate is permitted to register for the Dissertation Work after satisfying the attendance requirement in all the courses, both theory and laboratory.

7.11 After satisfying the previous clause, a candidate must present in ***Dissertation Work Review - I***, in consultation with his Dissertation Supervisor, the title, objective and plan of action of his Dissertation work to the Dissertation Review Committee (DRC) for approval ***within four weeks*** from the commencement of **Second year First Semester**. Only after obtaining the approval of the DRC can the student initiate the Dissertation work.

7.12 If a candidate wishes to change his supervisor or topic of the Dissertation, he can do so with the approval of the DRC. However, the DRC shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of Dissertation proposal. If yes, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.

7.13 A candidate shall submit his Dissertation progress report in two stages at least with a gap of **three** months between them.

7.14 The work on the Dissertation shall be initiated at the beginning of the II year and the duration of the Dissertation is two semesters. A candidate is permitted to submit Dissertation Thesis only after successful completion of all theory and practical courses with the approval of DRC ***not earlier than 40 weeks*** from the date of approval of the Dissertation work. For the approval of DRC, the candidate shall submit the draft copy of thesis to the Head of the Department and make an oral presentation before the DRC.

7.15 ***The Dissertation Work Review - II*** in II Year I Semester carries 100 internal marks. Evaluation should be done by the DRC for 50 marks and the Supervisor will evaluate the work for the other 50 marks. The Supervisor and DRC will examine the Problem Definition, Objectives, Scope of Work, Literature Survey in the same domain and progress of the Dissertation Work. A candidate has to secure a minimum of 50% of marks to be declared successful in Dissertation Work Review - II. If he fails to obtain the minimum required marks, he has to reappear for Dissertation Work Review - II as and when conducted.

7.16 ***The Dissertation Work Review - III*** in II Year II Sem. carries 100 internal marks. Evaluation should be done by the DRC for 50 marks and the Supervisor will evaluate it for the other 50 marks. The DRC will examine the overall progress of the Dissertation Work and decide whether or not the Dissertation is eligible for final submission. A candidate has to secure a minimum of 50% of marks to be declared successful in Dissertation Work Review - III. If he fails to obtain the required minimum marks, he has

to reappear for Dissertation Work Review - III as and when conducted. For Dissertation Evaluation (Viva Voce) in II Year II Semester there are external marks of 100 and it is evaluated by the external examiner. The candidate has to secure a minimum of 50% marks in Dissertation Evaluation (Viva- Voce) examination.

7.17 Dissertation Work Reviews - II and III shall be conducted in phase I (Regular) and Phase II (Supplementary). Phase II will be conducted only for unsuccessful students in Phase I. The unsuccessful students in Dissertation Work Review - II (Phase II) shall reappear for it at the time of Dissertation Work Review - III (Phase I). These students shall reappear for Dissertation Work Review - III in the next academic year at the time of Dissertation Work Review - II only after completion of Dissertation Work Review - II, and then Dissertation Work Review - III follows. The unsuccessful students in Dissertation Work Review - III (Phase II) shall reappear for Dissertation Work Review - III in the next academic year only at the time of Dissertation Work Review - II (Phase I).

7.18 After approval from the DRC, a soft copy of the thesis should be submitted for Anti-Plagiarism check and the plagiarism report should be submitted to the University and be included in the final thesis. The Thesis will be accepted for submission, if the similarity index is less than **30%**. If the similarity index is more than the required percentage, the student is advised to revise the thesis and re-submit the soft copy of the thesis after one month. The maximum number of re-submissions of thesis after plagiarism check is limited to ***TWO***. The candidate has to register for the Dissertation work and work for two semesters. After three attempts, the admission is liable to be cancelled.

7.19 Three copies of the Dissertation Thesis certified by the supervisor shall be submitted to the College/School/Institute.

7.20 The thesis shall be adjudicated by an external examiner selected by the University. For this, the Principal of the College/School/Institute shall submit a panel of **three** examiners from among the list of experts in the relevant specialization as submitted by the supervisor concerned and Head of the Department.

7.21 If the report of the external examiner is unsatisfactory, the candidate shall revise and resubmit the Thesis. If the report of the examiner is unsatisfactory again, the thesis shall be summarily rejected. Subsequent actions for such dissertations may be considered, only on the specific recommendations of the external examiner and /or Dissertation Review Committee. No further correspondence in this matter will be entertained, if there is no specific recommendation for resubmission.

7.22 If the report of the examiner is satisfactory, the Head of the Department shall coordinate and decide for the conduct of Dissertation Viva-Voce examination. The Dissertation Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who adjudicated the Thesis. The candidate has to secure a minimum of 50% of marks in Dissertation Evaluation (Viva-Voce) examination.

7.23 If he fails to fulfill the requirements as specified in the above clause, he will reappear for the Dissertation Viva-Voce examination ***only after three months***. In the reappeared examination also, if he fails to fulfill the requirements, he will not be eligible for award of the degree, unless he is asked to revise and resubmit his Dissertation Work by the board within a specified time period.

7.24 The Dissertation Viva-Voce External examination marks must be submitted to the University on the same day of the examination.

7.25 For Audit courses, a student has to secure 40 marks out of 100 marks (i.e. 40% of the marks allotted) in the continuous internal evaluation for passing the course. These marks should also be uploaded along with the internal marks of other courses.

7.26 No marks or letter grades shall be allotted for Audit Courses. Only Pass/Fail shall be indicated in Grade Card.

8.0 Re-Admission/Re-Registration

8.1 Re-Admission for Discontinued Student

A student, who has discontinued the M. Tech. degree programme due to any reason whatsoever, may be considered for '**readmission'** into the same degree programme (with the same specialization) with the

academic regulations of the batch into which he gets readmitted, with prior permission from the authorities concerned.

8.2 If a student is detained in a course (s) due to shortage of attendance in any semester, he may be permitted to **re-register** for the same course(s) or the student may register in an equivalent course, If the same course is not available, as suggested by the Board of Studies of that department, in the subsequent semester(s), with the academic regulations of the batch into which he seeks re-registration, with prior permission from the authorities concerned.

8.3 A candidate shall be given chance to re-register any number of courses, if the candidate failed in these courses due to securing less than 40% marks in CIE. A candidate must re-register for failed courses within four weeks of commencement of the class work, in the next academic year and secure the required minimum attendance. In the event of the student taking this chance, his Continuous Internal Evaluation (internal) marks and Semester End Examination marks obtained in the current semester only will be accepted, if he secures pass grade.

9.0 Examinations and Assessment - The Grading System

9.1 Grades will be awarded to indicate the performance of each student in each Theory Course, or Lab/Practicals, or Mini Project with Seminar, Dissertation, etc., based on the percentage of marks obtained in CIE + SEE (Continuous Internal Evaluation + Semester End Examination, both taken together), and a corresponding Letter Grade shall be given.

9.2 As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades (UGC Guidelines) and corresponding percentage of marks shall be followed:

% of Marks Secured in a Course (Class Intervals)	**Letter Grade (UGC Guidelines)**	**Grade Points**
90% and above (≥ 90%, ≤ 100%)	O (Outstanding)	10
Below 90% but not less than 80% (≥80%, <90%)	A^+ (Excellent)	9
Below 80% but not less than 70% (≥70%, <80%)	A (Very Good)	8
Below 70% but not less than 60% (≥60%, <70%)	B^+ (Good)	7
Below 60% but not less than 50% (≥ 50%, <60%)	B (above Average)	6
Below 50% (< 50%)	F (FAIL)	0
Absent	**Ab**	**0**

9.3 A student obtaining **'F'** Grade in any Course is deemed to have 'failed' and is required to reappear as 'Supplementary Candidate' for the Semester End Examination (SEE), as and when conducted. In such cases, his Internal Marks (CIE Marks) in those courses will remain as obtained earlier.

9.4 If a student has not appeared for the examinations, '**Ab**' Grade will be allocated to him for any course and shall be considered 'failed' and will be required to reappear as 'Supplementary Candidate' for the Semester End Examination (SEE), as and when conducted.

9.5 A Letter Grade does not imply any specific marks percentage; it is only the range of percentage of marks.

9.6 In general, a student shall not be permitted to repeat any Course (s) only for the sake of 'Grade Improvement' or 'SGPA/ CGPA Improvement'.

9.7 A student earns Grade Point (GP) in each Course, on the basis of the Letter Grade obtained by him in that Course. The corresponding 'Credit Points' (CP) are computed by multiplying the Grade Point with Credits for that particular Course.

Credit Points (CP) = Grade Point (GP) x Credits …. For a Course

9.8 The student passes the Course only when he **gets GP 6 (B Grade or above).**

9.9 The Semester Grade Point Average (SGPA) is calculated by dividing the Sum of Credit Points secured from all Courses registered in a Semester, by the total number of credits offered in that Semester. SGPA is rounded off to two decimal places. SGPA is thus computed as

$$\text{SGPA} = \{ \sum_{i=1}^{N} C_i G_i \} \Big/ \{ \sum_{i=1}^{N} C_i \} \text{ .... For each Semester}$$

where 'i' is the Course indicator index (taking into account all Courses in a Semester), 'N' is the no. of Courses offered in the Semester (as specifically required and listed under the Course Structure of the parent Department), C_i is the no. of Credits allotted to the i^{th} Course, and G_i represents the Grade Points corresponding to the Letter Grade awarded for that i^{th} Course.

9.10 The Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student over all Semesters considered for registration. The CGPA is the ratio of the Total Credit Points secured by a student in all registered Courses in all Semesters, and the Total Number of Credits registered in all the Semesters. CGPA is rounded off to two decimal places. CGPA is thus computed from the I Year Second Semester onwards, at the end of each Semester, as per the formula

$$\text{CGPA} = \{ \sum_{j=1}^{M} C_j G_j \} \Big/ \{ \sum_{j=1}^{M} C_j \}$$

(ie., up to and inclusive of S Semesters, S ≥ 2),

where 'M' is the total no. of Courses (as specifically required and listed under the Course Structure of the parent Department) the Student has 'registered'. C_j is the no. of Credits allotted to the j^{th} Course, and G_j represents the Grade Points (GP) corresponding to the Letter Grade awarded for that j^{th} Course. After registration and completion of I Year I Semester however, the SGPA of that Semester itself may be taken as the CGPA, as there are no cumulative effects.

Illustration of calculation of SGPA

Course	Credits	Letter Grade	Grade points	Credit Points
Course 1	4	A	8	4*8 = 32
Course 2	4	O	10	4*10 = 40
Course 3	4	B	6	4*6 = 24
Course 4	3	B	6	3*6 = 18
Course 5	3	A+	9	3*9 = 27
Course 6	3	B	6	3*6 = 18
	21			159

SGPA = 159/21 = 7.57

Illustration of calculation of CGPA from SGPA

Semester	Credits	SGPA	Credits * SGPA
Semester I	24	7	24*7 = 168
Semester II	24	6	24*6 = 144
Semester III	24	6.5	24*6.5 = 156
Semester IV	24	6	24*6 = 144
	96		612

CGPA = 612/96 = 6.37

10.0 Award of Degree and Class

10.1 If a student who registers for all the specified Courses as listed in the Course Structure, satisfies all the Course Requirements, and passes the examinations prescribed in the entire PG Programme, and secures the required number of **68** Credits (with CGPA ≥6.0), shall be declared to have 'qualified' for the award of

the M.Tech. Degree in the chosen Branch of Engineering/Technology with the specialization that he was admitted into.

10.2 Award of Class

After a student has earned the requirements prescribed for the completion of the programme and is eligible for the award of M.Tech. Degree, he shall be placed in one of the following three classes based on the CGPA:

Class Awarded	CGPA
First Class with Distinction	≥ 7.50
First Class	6.50≤ CGPA < 7.50
Second Class	6.00≤ CGPA < 6.50

A student with final CGPA (at the end of the **PGP) < 6.00** shall not be eligible for the Award of Degree.

11.0 Withholding of Results

If the student has not paid the dues, if any, to the University or if any case of indiscipline is pending against him, the result and degree of the student will be withheld and he will not be allowed into the next semester.

12.0 Conversion of CGPA into equivalent Percentage of Marks

The following formula shall be used for the conversion of CGPA into equivalent marks, whenever it is necessary

Percentage (%) of Marks = (Final CGPA – 0.5) x 10

13.0 Mapping with the Sustainable Development Goals

All the courses specified in the course structure of every programme are mapped with the one or more sustainable development goals.

14.0 General

14.1 **Credit**: A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.

14.2 **Credit Point:** It is the product of grade point and number of credits for a course.

14.3 Wherever the words “he”, “him”, “his”, occur in the regulations, they shall include “she”, “her”.

14.4 The academic regulation should be read as a whole for the purpose of any interpretation.

14.5 In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the University is final.

14.6 The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

Malpractices Rules
Disciplinary Action For / Improper Conduct in Examinations

Rule	Nature of Malpractices/ Improper conduct	Punishment
	If the student:	

1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which student is appearing but has not made use of (material shall include any marks on the body of the student which can be used as an aid in the subject of the examination).	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other student orally or by any other body language methods or communicates through cell phones with any student or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the students involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the student is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The hall ticket of the student is to be cancelled
3.	Impersonates any other student in connection with the examination.	The student who has impersonated shall be expelled from examination hall. The student is also debarred and forfeits the seat. The performance of the original student who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The student is also debarred for two consecutive semesters from class work and all college examinations. The continuation of the course by the student is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.

4.	Smuggles in the answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the student has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred for two consecutive semesters from class work and all college examinations. The continuation of the course by the student is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the chief superintendent/COE/ACoE/any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the college campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the student(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The students also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears off the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the student has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred for two consecutive semesters from class work and all college examinations. The continuation of the course by the student is subject to the academic regulations in connection with forfeiture of seat.

8.	Possesses any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred and forfeits the seat.
9.	If student of the college, who is not a student for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The student is also debarred and forfeits the seat. Person(s) who do not belong to the college will be handed over to the police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the student has already appeared for including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the student has appeared for including practical examinations and project work of that semester/year examinations.
12	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the Principal for further action to award a suitable punishment.	

Malpractices identified by squad or special invigilators

1. Punishments to the students as per the above guidelines.
2. Punishment for staff: (if the squad reports that the staff is also involved in encouraging malpractices)
   a. A show-cause notice shall be issued to the staff.
   b. Impose a suitable fine on the staff.

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M.Tech. – Thermal Engineering (R25)

I M.Tech I Semester

Course Code	Course Title	Category	Hours per Week			Credits	Scheme of Examination Maximum Marks		
			L	T	P		Internal (CIE)	External (SEE)	Total
B62101	Advanced Thermodynamics	PCC	3	0	0	3	40	60	100
B62103	Advanced Fluid Mechanics	PCC	3	0	0	3	40	60	100
	Professional Elective - I	PEC	3	0	0	3	40	60	100
	Professional Elective - II	PEC	3	0	0	3	40	60	100
B6HS01	Research Methodology & IPR	ESC	2	0	0	2	40	60	100
B62102	Advanced Thermal Engineering lab	PCC	0	0	4	2	40	60	100
B62104	Advanced Fluid Mechanics Lab	PCC	0	0	4	2	40	60	100
	Audit Course–I	MC	2	0	0	0	40	60	100
TOTAL			**16**	**0**	**8**	**18**	**320**	**480**	**800**

I M.Tech. II Semester

Course Code	Course Title	Category	Hours per Week			Credits	Scheme of Examination Maximum Marks		
			L	T	P		Internal(CIE)	External (SEE)	Total
B62107	Advanced Heat and Mass Transfer	PCC	3	0	0	3	40	60	100
B62109	Computational Fluid Dynamics	PCC	3	0	0	3	40	60	100
	Professional Elective- III	PEC	3	0	0	3	40	60	100
	Professional Elective - IV	PEC	3	0	0	3	40	60	100
B62111	Mini Project with Seminar	PWC	0	0	4	2	100	0	100
B62108	Advanced Heat Transfer Lab	PCC	0	0	4	2	40	60	100
B62110	Computational Methods Lab	PCC	0	0	4	2	40	60	100
	Audit Course-II	MC	2	0	0	0	40	60	100
TOTAL			**14**	**0**	**12**	**18**	**380**	**420**	**800**

II M.Tech. I Semester

Course Code	Course Title	Category	Hours per Week			Credits	Scheme of Examination Maximum Marks		
			L	T	P		Internal (CIE)	External (SEE)	Total
	Professional Elective-V	PEC	3	0	0	3	40	60	100
	Open Elective	OEC	3	0	0	3	40	60	100
B62113	Dissertation Work Review-I	PWC	0	0	18	6	100	0	100
TOTAL			**6**	**0**	**18**	**12**	**180**	**120**	**300**

II M.Tech. II Semester									
Course Code	Course Title	Category	Hours per Week			Credits	Scheme of Examination Maximum Marks		
			L	T	P		Internal (CIE)	External (SEE)	Total
B62114	Dissertation Work Review-II	PWC	0	0	18	6	100	0	100
B62115	Dissertation Viva-Voce	PWC	-	-	42	14	0	100	100
TOTAL			**0**	**0**	**50**	**20**	**100**	**100**	**200**

PROFESSIONAL ELECTIVE COURSES			
PE - I		**PE - II**	
B62116	Fuels &Combustion	B62119	Advanced I.C. Engines
B62117	Electric & Hybrid Vehicles	B62120	Gas turbines & Jet Propulsion
B62118	Experimental Methods in Thermal Engineering	B62121	Nano Fluids
PE - III		**PE- IV**	
B62122	Finite Element Analysis	B62125	Cogeneration & Waste Heat Recovery Systems
B62123	Optimization Techniques & Applications	B62126	Renewable Energy Sources
B62124	Utilization of Solar energy	B62127	Energy conservation and Management
PE - V			
B62128	Refrigeration & HVAC		
B62129	Gas Dynamics		
B62130	Equipment Design for Thermal Systems		

OPEN ELECTIVES FOR OTHER DEPARTMENTS	
B62135	Industrial Safety
B62136	Operations Research

AUDIT COURSE I		AUDIT COURSE II	
B6AC01	English for Research Paper Writing	B6AC05	Disaster Management
B6AC02	Sanskrit for Technical Knowledge	B6AC06	Constitution of India
B6AC03	Value Education	B6AC07	Pedagogy Studies
B6AC04	Stress Management by yoga	B6AC08	Personality Development Through Life Enlightenment Skills

I M.TECH. I SEMESTER SYLLABUS

ADVANCED THERMODYNAMICS

I Year / I Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62101	PCC	3	0	0	3	40	60	100

COURSE OBJECTIVES:

This course will enable students to

1. Provide analytical methods for the determination of the direction of processes from the first and second laws of thermodynamics and to Introduce methods in using equations of potentials, availability, and exergy for thermodynamic analysis
2. Gain the knowledge on non-reactive mixture properties, Psychometric Mixture properties and psychometric chart and Air conditioning processes
3. Develop the ability of analyzing vapor and Gas power cycles
4. Provide in depth knowledge of Direct Energy Conversion of Fuel Cells, Thermo electric energy, Thermionic power generation, Thermodynamic devices Magneto Hydrodynamic Generations and Photo voltaic cells
5. Develop communication and teamwork skills in the collaborative course project

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COURSE OUTCOMES:

At the end of the course students are able to

1. Explain basic thermodynamic concepts and laws
2. Describe the concepts entropy and exergy and their use in analyses of thermal energy systems
3. Analyze power plants, refrigeration plants and thermal/chemical installations
4. Evaluate means for minimizing exergy losses in selected processes
5. Use advanced thermodynamics on a research case

UNIT-I REVIEW OF THERMODYNAMIC LAWS AND COROLLARIES:

Transient flow analysis, Second law of thermodynamics, Entropy, Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Mayer's relation. Evaluation of thermodynamic properties of working substance.

UNIT-II P.V.T SURFACE

Equation of state. Real gas behavior, Vander Waal's equation, Generalization compressibility factor. Energy properties of real gases. Vapour pressure, Clausius-Clapeyro equation. Throttling, Joule Thompson coefficient. Non-reactive mixtures of perfect gases. Governing laws, Evaluation of properties, Psychometric mixture properties and psychometric chart, Air conditioning processes, cooling towers. Real gas mixture.

UNIT- III COMBUSTION

Combustion Reactions, Enthalpy of formation. Entropy of formation, Reference levels of tables. Energy of formation, Heat reaction, Adiabatic flame temperature generated product, Enthalpies, Equilibrium. Chemical equilibrium of ideal gases, Effect of non-reacting gases equilibrium in multiple reactions, The Vent Hoff's equation. The chemical potential and phase equilibrium. The Gibbs phase rule.

UNIT- IV	POWER CYCLES
Review binary vapour cycle, co generation and combined cycles, Second law analysts of cycles. Refrigeration cycles, Thermodynamics of irreversible processes. Introduction, Phenomenological laws, Onsager Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production, Thermodynamic phenomena, Thermo electric circuits.	
UNIT-V	**DIRECT ENERGY CONVERSION INTRODUCTION**
Fuel cells, Thermo electric energy, Thermo ionic power generation, Thermodynamic devices magneto hydrodynamic generations, Photovoltaic cells.	

Text Books:

1. Basic and Applied Thermodynamics by P. K. Nag, TMH
2. Engineering Thermodynamics by Rogers & Mayhew, Pearson
3. Thermodynamics by Holman, Mc Graw Hill.

Reference Books:

1. Thermal Engineering by Rathore, TMH
2. Applied Thermodynamics by R.K. Rajput, Laxmi Publications
3. Thermal Engineering by Soman, PHI
4. Engineering Thermodynamics by P. L. Dhar, Elsevier
5. Thermodynamics by Sonnatag& Van Wylen, John Wiley & Sons
6. Thermodynamics for Engineers by Doolittle-Messe, John Wiley & Sons
7. Irreversible Thermodynamics by HR De Groff.
8. Thermodynamics & Heat Power by Granet& Bluestein, CRC Press
9. Engineering Thermodynamics by Chatopadyaya

ADVANCED FLUID MECHANICS

I Year / I Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62103	PCC	3	0	0	3	40	60	100

COURSE OBJECTIVES:

1. Establish an understanding of the fundamental concepts of fluid mechanics.
2. Understand and apply the potential flow equations to basic flows.
3. Understand and apply the differential equations of fluid mechanics including the ability to apply and understand the impact of assumptions made in the analysis.
4. Understand the boundary layer concepts with respect to fluid flow.
5. Understand and apply the compressible flow equations.

COURSE OUTCOMES:

At the end of the course students are able to

1 Understanding the concept of fluid and the models of fluids.
2 Understanding the basic physical meaning of general equations.
3 Understanding the concept of stream function and potential function.
4 Ability to derive the equation for viscous flow, including laminar flow and turbulent flow.
5 Ability to address such problems in engineering, and to solve the problems

UNIT-I Inviscid Flow of Incompressible Fluids

Lagrangian and Eulerain Descriptions of fluid motion- Path lines, Stream lines, Streak lines, stream tubes – velocity of a fluid particle, types of flows, Equations of three-dimensional continuity equation- Stream and Velocity potential functions.

Basic Laws of fluid Flow: Condition for irrotationality, circulation & vorticity Accelerations in Carte systems normal and tangential accelerations, Euler's, Bernoulli equations in 3D– Continuity and Momentum Equations

UNIT-II Viscous Flow

Derivation of Navier-Stoke's Equations for viscous compressible flow – Exact solutions to certain simple cases: Plain Poiseuille flow - Coutte flow with and without pressure gradient - Hagen Poiseuille flow - Approximate solutions – Creeping motion (Stokes) – Oseen's approximation.

UNIT-III Boundary Layer Theory

Prandtl's contribution to real fluid flows – Prandtl's boundary layer theory - Boundary layer thickness for flow over a flat plate – Von-Karman momentum integral equation - Blasius solution- Laminar boundary layer – Turbulent Boundary Layer — Expressions for local and mean drag coefficients for different velocity profiles. – Total Drag due to Laminar & Turbulent Layers – Problems

UNIT-IV Introduction to Turbulent Flow

Fundamental concept of turbulence – Time Averaged Equations – Boundary Layer Equations - Prandtl Mixing Length Model - Universal Velocity Distribution Law: Van Driest Model –Approximate solutions for drag coefficients – More Refined Turbulence Models – k-epsilon model - boundary layer separation and form drag – Karman Vortex Trail, Boundary layer control, lift on circular cylinders

Internal Flow: Smooth and rough boundaries – Equations for Velocity Distribution and frictional Resistance in smooth rough Pipes – Roughness of Commercial Pipes – Moody's diagram.

UNIT-V **Compressible Fluid Flow – I & II**

Compressible Fluid Flow – I: Thermodynamic basics – Equations of continuity, Momentum and Energy - Acoustic Velocity Derivation of Equation for Mach Number – Flow Regimes – Mach Angle – Mach Cone – Stagnation State

Compressible Fluid Flow – II: Area Variation, Property Relationships in terms of Mach number, Nozzles, Diffusers – Fanno and Releigh Lines, Property Relations – Isothermal Flow in Long Ducts – Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks – Supersonic Wave Drag

Text Books:

1. Fluid Mechanics and Fluid Machines by S K Som and G Biswas, TMH
2. Fluid Mechanics by Joseph H Spurk and NuriAksel, Springer
3. Compressible Fluid Dynamics by B K Hodge and Keith Koenig, Pearson
4. Fluid Mechanics by Potter, Cengage Learning.
5. Fluid Mechanics and Hydraulic Machines by Dr. R.K. Bansal.

Reference Books:

1. Computational Methods for Fluid Dynamics by Ferziger and Peric, Springer Publication.
2. An Introduction to Computational Fluid Mechanics by Chuen-Yen Chow, Wiley Publication.
3. Computational Fluid Flow & Heat Transfer by Murlidhar and Sundarrajan, NarosaPublication.

RESEARCH METHODOLOGY & IPR

I Year / I Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B6HS01	ESC	2	0	0	2	40	60	100

Course Objectives:

1. To understand the research problem
2. To know the literature studies, plagiarism and ethics
3. To get the knowledge about technical writing
4. To analyze the nature of intellectual property rights and new developments
5. To know the patent rights

Course Outcomes: At the end of this course, students will be able to

1. Understand research problem formulation.
2. Analyze research related information
3. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
4. Understanding that when IPR would take such important place in growth of individuals &nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT-I: INTRODUCTION

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT-II: RESEARCH ETHICS

Effective literature studies approaches, analysis, Plagiarism, Research ethics

UNIT-III: RESEARCH PROPOSAL

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT-IV: INTELLECTUAL PROPERTY

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-V: IPR

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent

System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TEXT BOOKS:

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students”
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”.

REFERENCES:

1. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Asimov, “Introduction to Design”, Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016.
7. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

ADVANCED THERMAL ENGINEERING LAB

I Year / I Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62102	PCC	0	0	4	2	40	60	100

COURSE OBJECTIVES:

1. Understanding the basic concept and working of refrigerator and IC engines.
2. To learn the basic principle of air conditioning system and its COP.
3. To learn the basic working of solar collector
4. To learn the basic working of solar water heater

COURSE OUTCOMES:

1. Examine the performance parameters of internal combustion engines
2. Analyze the performance and working of refrigeration and air conditioning systems.
3. Analyze performance of heat pipe.
4. Analyze performance characteristics of solar energy equipment.
5. Determine dryness fraction of steam using separating and throttling calorimeter.

LIST OF EXPERIMENTS:

1. Heat balance sheet of an IC engine
2. Determination of volumetric efficiency and A/F ratio of an IC Engine.
3. Performance test and analysis of exhaust gases of an IC Engine.
4. Performance analysis of heat pipe
5. Valve timing & Port timing diagram
6. COP estimation of vapour compression refrigeration system
7. Performance analysis of Air conditioning unit.
8. Performance analysis of solar flat plate collector test Rig.
9. Performance characteristics of solar evacuated tube collector test Rig.
10. Study of IV characteristics of solar radiation energy.
11. Study of power generation using solar radiation energy.
12. Determination of actual dryness fraction of steam using separating and throttling calorimeter test Rig.

Advanced Fluid Mechanics Lab

I Year / I Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
B62104	PCC	0	0	4	2	40	60	100

COURSE OBJECTIVES:

- To identify the behavior of analytical models introduced in lecture to the actual behavior of real fluid flows.
- To explain the standard measurement techniques of fluid mechanics and their applications.
- To illustrate the students with the components and working principles of the Hydraulic machines- different types of Turbines, Pumps, and other miscellaneous hydraulics machines.
- To analyze the laboratory measurements and to document the results in an appropriate format.

COURSE OUTCOMES:

At the end of the course students are able to

1 Describe the measurement techniques of fluid mechanics and its appropriate application.
2 Interpret the results obtained in the laboratory for various experiments.
3 Compare the results of analytical models introduced in lecture to the actual behavior of real fluid flows and draw correct and sustainable conclusions.
4 Write a technical laboratory

LIST OF EXPERIMENTS:

1. Jet impact on flat and curved surfaces
2. Determination of friction factor as a function of Reynolds number in pipe flow
3. Studying laminar-turbulent transition for flow in a tube
4. Measure the losses in piping System
5. Measure Friction loss along a pipe
6. Flow Measuring Apparatus, (H10 Setup)
7. Flow through an Orifice (H4 Setup)
8. Water Flow Channel (H17 Setup)
9. Bernoullis Apparatus,
10. Francis Turbine Apparatus,
11. Multi Stage Pump Apparatus,

I M.TECH II SEMESTER SYLLABUS

ADVANCED HEAT AND MASS TRANSFER

I Year / II Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62107	PCC	3	0	0	3	40	60	100

COURSE OBJECTIVES:

1. Heat transfer concepts for various applications like finned systems, turbulence flows, high speed flows.
2. Analysis of thermal analysis and sizing of heat exchangers and to learn the heat transfer coefficient for compact heat exchanges.
3. Concepts of phase change processes and mass transfer.

COURSE OUTCOMES:

At the end of course students are able to

1 Mathematically model heat and mass transfer and fluid flow problems and to be able to apply different boundary conditions
2 Solve the simple heat and mass transfer and fluid flow problems using analytical methods and appreciate the need of numerical methods to solve complicated problems
3 Apply semi empirical formulae to determine the heat transfer parameters and use different techniques, viz., experimental, analytical and semi empirical methods to design the thermal systems.

UNIT-I INTRODUCTION

Governing Laws and mathematical models -Initial and boundary conditions.
Heat Conduction – Development of Governing equation for 1D, 2D and 3D; steady and transient heat conduction – Solution of 1D steady state heat conduction – Composite Systems.
Systems with heat generation – Variable thermal conductivity – Fins
2D Steady State Heat conduction – Use of conduction shape factors – Use of analytical method for temperature distribution in a slab for simple boundary conditions

UNIT-II TRANSIENT HEAT CONDUCTION & FORCED CONVECTION

Transient heat conduction: Lumped system analysis-Infinite Bodies - Heisler charts-semi infinite solid -2D transient heat conduction using product solutions.
Forced Convection: Equations of fluid flow-concepts of continuity, momentum equations-derivation of energy equation-methods to determine heat transfer coefficient: Analytical methods-dimensional analysis and concept of exact solution. Approximate method-integral analysis – Von Karman Integral Momentum and Energy Equations – Determination of laminar heat transfer coefficient for different velocity and temperature profiles for flow over a flat plate

UNIT-III EXTERNAL AND INTERNAL FLOWS

External flows: Flow over a flat plate: Application of empirical relations to various geometries for laminar and turbulent flows.
Internal flows: Flow Classification based on hydrodynamic &thermal entry lengths- Fully developed flow: integral analysis for laminar heat transfer coefficient-constant wall temperature and constant heat flux

boundary conditions-; use of empirical correlations for determination of heat transfer coefficient and friction factor for different types of internal flow applications.

UNIT-IV	FREE CONVECTION

FREE CONVECTION: Approximate analysis on laminar free convective heat transfer-Boussinesque approximation-different geometries-combined free and forced convection.
Boiling and condensation: Boiling curve-correlations-Nusselt's theory of film condensation on a vertical plate-assumptions & correlations of film condensation for different geometries.

UNIT-V	RADIATION HEAT TRANSFER

Radiation Heat Transfer: Radiant heat exchange in grey, non-grey bodies, with transmitting. Reflecting and absorbing media, specular surfaces, gas radiation-radiation from flames.
Mass Transfer: Concepts of mass transfer-diffusion & convective mass transfer analogies-significance of non-dimensional numbers.
Recent Advances in Heat and Mass Transfer Applications.

Text Books:

1. Fundamentals of Heat Transfer by Incropera & Dewitt, John Wiley
2. Heat Transfer by Necati Ozisik, TMH
3. Heat Transfer: A Conceptual Approach by P K Sharma and K Rama Krishna.

Reference Books:

1. Heat Transfer by Holman J.P, Mc Graw Hill Publication
2. Heat Transfer by Gregory Nellis & Sanford Klein, Cambridge University Press
3. Principals of Heat Transfer by Frank Kreith, Cengage Learning
4. Introduction to Heat Transfer by SK Som, PHI
5. Heat Transfer by Nellis & Klein, Cambridge University Press, 2012.
6. Engineering Heat & Mass Transfer by Sarit K. Das, Dhanpat Rai
7. Heat Transfer by P. K. Nag, TMH

COMPUTATIONAL FLUID DYNAMICS

I Year / II Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62109	PCC	3	0	0	3	40	60	100

COURSE OBJECTIVES:

This course will enable students to apply the principles of Heat Transfer and Fluid Mechanics to solve simple heat transfer and fluid flow problems using different numerical techniques

COURSE OUTCOMES:

At the end of the course students are able to

1 Differentiate between different types of Partial Differential Equations and to be able to apply appropriate numerical techniques
2 Solve the simple heat transfer and fluid flow problems using different numerical techniques
3 Understand and to appreciate the need for validation of numerical solution

UNIT-I REVIEW OF GOVERNING EQUATIONS IN HEAT TRANSFER AND FLUID FLOW

Review of Governing Equations in Heat Transfer and Fluid Flow: Conservation Laws – Differential Form of Equations – Characteristics of Governing Equations - Solution Methods: Analytical, Experimental and Numerical Methods – Review of Boundary Conditions
Introduction to Numerical Methods - Brief about Finite Difference, Finite Element and Finite Volume Methods – Solution of Linear Algebraic Equations – Direct and Iterative Approaches
Mathematical Behavior of Partial Differential Equations: Classification of Partial Differential Equations – Illustrations
Finite Difference Method: Taylor's series – Derivation of Finite Difference Formulae for Partial Derivative Terms - FD formulation of 1D Elliptic PDEs - 1D steady state heat transfer problems – Cartesian, cylindrical and spherical co-ordinate systems –- boundary conditions

UNIT-II FINITE DIFFERENCE METHOD

Finite Difference Method: 2D Elliptic PDEs – 2D Steady State Heat Conduction Problems. Parabolic PDEs - Transient heat conduction – Errors and Stability - Explicit Method – Stability Analysis – Implicit and Crank Nickolson method – 2-D Parabolic PDEs - Finite Difference formulation – ADI Method and explicit Method – Finite Difference Formulation of 1D Hyperbolic PDEs - Wave Equation

UNIT-III FINITE VOLUME METHOD

Finite Volume Method: Formation of Basic rules for Finite Volume approach – General Nodal Equation - Interface Thermal Conductivity -– Treatment of Source Term and Treatment of Nonlinearity.

Solution of 1D and 2D Elliptic PDEs - Heat conduction problems - Solution of 1D Parabolic PDEs – Explicit Method and Implicit Methods- Transient Heat conduction problems

UNIT-IV	FVM TO CONVECTION AND DIFFUSION

FVM to Convection and Diffusion: General Form of Governing Equations for Fluid Flow and Heat transfer – Burger's equation - Steady 1D Convection Diffusion – Discretization Schemes and their assessment – Treatment of Boundary Conditions.

UNIT-V	CALCULATION OF FLOW FIELD:

Calculation of Flow Field: Vorticity & Stream Function Method – Advantages and Disadvantages – Treatment of Boundary Conditions - Staggered Grid as Remedy for representation of Flow Field - Pressure Velocity Coupling - SIMPLE & SIMPLER (revised algorithm) Algorithms.
Compressible Flows: Introduction - Pressure, Velocity and Density Coupling.

Text Books:

1. Numerical heat transfer and fluid flow – S.V. Patankar (Hemisphere Pub. House)
2. An Introduction to Computational Fluid Dynamics – FVM Method – H.K.Versteeg, W. Malalasekhara (PHI)
3. Computational Fluid Flow and Heat Transfer by Muralidharan & Sundarajan (Narosa Pub)
4. Computational Fluid Dynamics and Heat Transfer by P. S. Ghoshdastidar, Centage Pub

Reference Books:

1.Computational Fluid Dynamics by Hoffman and Chiang, Engg Education System
2.Computational Fluid Dynamics by Anderson, TMH
3.Computational Methods for Fluid Dynamics by Ferziger, Peric, Springer
4.Computational Fluid Dynamics by T.J. Chung, Cambridge University
5.Computational Fluid Dynamics by A Practical Approach – Tu, Yeoh, Liu, Elsevier
6.Text Book of Fluid Dynamics by Frank Chorlton, CBS Publishers

ADVANCED HEAT TRANSFER LAB

I Year / II Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62108	PCC	0	0	4	2	40	60	100

COURSE OBJECTIVES:

To apply the principles of Heat Transfer to determine various Heat transfer and Fluid Flow Parameters

COURSE OUTCOMES:

At the end of the course students are able to

1. Determine the thermal property of the solids using energy balance and also using unsteady state analysis
2. Determine the heat transfer coefficient of air in free and force convective conditions
3. Determine the performance of Recuperative Type heat exchangers
4. Determine the drag acting on different surfaces and its effects on pumping power
5. Determine performance of thermal equipment like Heat Pipe

LIST OF EXPERIMENTS:

1. Determination of Thermal Conductivity of a Metal Rod using Searle's Apparatus
2. Determination of thermal Conductivity of a thin disc using Lee's Disc Apparatus
3. Determination of Free Convective Heat Transfer Coefficient of air Using Vertical Rod
4. Determination of Forced Convective Heat Transfer Coefficient of air using Forced Convection Apparatus
5. Determination of Performance of a Heat Pipe
6. Determination of the effectiveness of Parallel and Counter Flow Heat Exchanger
7. Determination of Condensation Heat Transfer Coefficient under Film and Dropwise Condensation Conditions
8. Heat exchanger service module with axillaries Tubular heat exchanger, shell & tube heat exchanger, plate heat exchanger, jacketed vessel with coil and stirrer.
9. Determination of Stefan Boltzmann Constant.
10. Determination of overall heat transfer coefficient using shell & tube heat exchanger.
11. Transient Heat Conduction Experiment.

COMPUTATIONAL METHODS LAB

I Year / II Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62110	PCC	0	0	4	2	40	60	100

COURSE OBJECTIVES:

To apply the principles of Heat Transfer and Fluid Mechanics to solve simple heat transfer and fluid flow problems using commercial CFD software

COURSE OUTCOMES:

At the end of the course students are able to

1. Analyze flow in axial turbine stage, mixing tube, mixing vessel
2. Draw 2-D structured grid generation using Salome..
3. Draw 3-D unstructured grid generation using Salome.
4. Solve the simple heat transfer and fluid flow problems
5. Understand and to appreciate the need for validation of numerical solution

LIST OF EXPERIMENTS:

1 Simulation of Couette flow when the upper plate is moving with a velocity of 40 m/s. Take the distance between the plates as 4 cm. Properties of fluid are; v = 0.000217 m2/s, ρ= 800 kg/m3. Make simulations for a pressure gradient of 0-30000 N/m2/m and 20000 N/m2/m and report the variation of velocity contours for each case.

2 Simulation of a channel flow (Tube flow) for a tube of diameter, 5 cm and take the fluid as water at 300C at the entry of the tube of length 0.7 m. A heat flux of 30000 W/m2 is imposed along the wall. Obtain the contours of velocity and temperature along the length of the tube and also obtain the centre line temperature and velocity of fluid.

3 Simulation of a channel flow (Tube flow) for a tube of diameter, 5 cm and take the fluid as water at 300C at the entry of the tube of length 0.7 m. A constant wall temperature of 3000C is imposed along the wall. Obtain the contours of velocity and temperature along the length of the tube and also obtain the centre line temperature and velocity of fluid.

4 Unsteady simulation of compressible flow of air through 2D a convergent – divergent nozzle, with inlet and outlet of 0.2 m size and both are joined by a throat section where the flow area is reduced by 10% and is of sinusoidal shape. Air enters the nozzle at a pressure of 0.9 atm and leaves at 0.73 atm. Obtain the contours of velocity, pressure and Mach number.

5 Simulation of flow over a circular cylinder of size 5 cm for different Reynold's number values of air and plotting the contours of velocity and vorticity.

6 Simulation of temperature contours for a square plate of size 0.2 m and subjected to different types of boundary conditions

7 Simulation of temperature contours for a pin fin subjected to natural and forced convective conditions

8 Simulation of Natural convection with and without radiation inside an enclosure

9 Simulation of Lid driven cavity problem

10 Structural analysis for beams and trusses

11 The experiments are to be conducted using ANSYS – CFX or equivalent software

PROFESSIONAL ELECTIVE-I

PROFESSIONAL ELECTIVE – I
FUELS &COMBUSTION

I Year / I Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62116	PEC	3	0	0	3	40	60	100

COURSE OBJECTIVES: The course is intended to make a post graduate student to understand

1. The fundamental of combustion phenomena in general
2. The different combustion process, its thermodynamics and kinetics
3. The combustion mechanism in different types of combustion
4. The burner design for efficient combustion
5. Different combustion models
6. The effect of quantity & quality of fuel and engine technology on exhaust emissions
7. The concept of laminar and turbulent flame propagation
8. Different methods to reduce air pollution

COURSE OUTCOMES: At the end of the course, the student will be able to**:**

1. Understand the concepts of combustion phenomena in energy conversion devices
2. Apply the knowledge of adiabatic flame temperature in the design of combustion devices
3. Identify the phenomenon of flame stabilization in laminar and turbulent flames
4. Analyze the pollution formation mechanisms in combustion of solid, liquid and gaseous fuels

UNIT–I: FUELS

Fuels: Detailed classification – Conventional and Unconventional Solid, Liquid, gaseous fuels and nuclear fuels – Origin of Coal – Analysis of coal.
Coal – Carborisation, Gasification and liquification – Lignite: petroleum-based fuels – problems associated with very low calorific value gases: Coal Gas – Blast Furnace Gas Alcohols and Biogas.

UNIT–II: PRINCIPLES OF COMBUSTION:

Principles of Combustion: Chemical composition – Flue gas analysis – dew point of products – Combustion stoichiometry.
Chemical kinetics – Rate of reaction – Reaction order – Molecularity – Zeroth, first, second and third order reactions - complex reactions – chain reactions. Theories of reaction Kinetics – General oxidation behavior of HC's.

UNIT–III: DETONATION AND DEFLAGRATION WAVES

Detonation and Deflagration waves of premixed gasses, Rankine Hygienist relation, Hygienist curve, laminar and turbulent flame propagation and structure**,** Burning velocity of fuels – Measurement of burning velocity – factors affecting the burning velocity.

UNIT–IV: FLAME STABILITY & COMBUSTION SYSTEMS

Flame Stability, Combustion of fuel, Theory of diffusion flames, droplets and sprays – Combustion systems – Pulverized fuel furnaces – fixed, Entrained and Fluidised Bed Systems.

UNIT–V: ENVIRONMENTAL CONSIDERATIONS

Environmental Considerations: Air pollution – Effects on Environment, Human Health etc. Principal pollutants – Legislative Measures – Methods of Emission control.

TEXT BOOKS:

1. Combustion Fundamentals by Roger A Strehlow, Mc Graw Hill
2. Fuels and combustion by Sharma and Chander Mohan, Tata Mc Graw Hill

REFERENCE BOOKS:

1. Combustion Engineering and Fuel Technology by Shaha A.K., Oxford and IBH.
2. Principles of Combustion by Kanneth K. Kuo, Wiley and Sons.
3. Fuels & Combustion by Sameer Circar, Mc. Graw Hill.
4. An Introduction to Combustion by Stephen R. Turns, Mc. Graw Hill International Edition.
5. Combustion Engineering by Gary L. Berman & Kenneth W. Ragland, Mc. Graw Hill International Edition.

PROFESSIONAL ELECTIVE – I
ELECTRIC & HYBRID VEHICLES

I Year / I Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62117	PEC	3	0	0	3	40	60	100

COURSE OBJECTIVES

1. Explain the history of Electric vehicles and development
2. Discuss the Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies
3. Explore to basic concept of electric traction, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives etc.
4. Analyse the Fuel Cell based energy storage and Super Capacitor based energy storage etc.
5. Explore to types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE & others) etc.

COURSE OUTCOMES : At the end of the course, the student will be able to**:**

1. Choose the appropriate source of energy for the hybrid electric vehicle based on driving cycle.
2. Analyze the power and energy need of the various hybrid electric vehicle and Measure and Estimate the energy consumption of the Hybrid Vehicles
3. Evaluate energy efficiency of the vehicle for its drive trains
4. Elaborate the types of storage systems such as battery based, fuel cell based etc.
5. Explain the types of Driving Cycles, Fuel Cell EV, Solar Powered Vehicles

UNIT-I: INTRODUCTION TO ELECTRIC VEHICLE:

INTRODUCTION TO ELECTRIC VEHICLE: History of Electric Vehicles, Development towards 21st Century, Types of Electric Vehicles in use today – Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles: various forces acting on the Vehicle in static and dynamic conditions.

UNIT-II: INDUCTION TO HYBRID ELECTRIC VEHICLE

INDUCTION TO HYBRID ELECTRIC VEHICLE: Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid Drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

UNIT-III: ELECTRIC DRIVE TRAINS:

ELECTRIC DRIVE TRAINS: Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

UNIT-IV: TYPES OF STORAGE SYSTEMS:

TYPES OF STORAGE SYSTEMS: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage

and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Calculation for the rating.

UNIT-V: MODELLING OF HYBRID ELECTRIC VEHICLE RANGE

MODELLING OF HYBRID ELECTRIC VEHICLE RANGE: Driving Cycles, Types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Case study of 2 wheeler, 3 wheeler and 4 wheeler vehicles.

TEXT BOOKS

1. James Larminie, J. Lowry, “Electric Vehicle Technology Explained”, John Wiley & Sons Ltd. 2003.
2. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004

REFERENCE BOOKS

1. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
2. Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2003.

PROFESSIONAL ELECTIVE – I
EXPERIMENTAL METHODS IN THERMAL ENGINEERING

I Year / I Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62118	PEC	3	0	0	3	40	60	100

Course Objectives

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

1. Understand the concepts of errors in measurements, statistical analysis of data, regression analysis, correlation and estimation of uncertainty.
2. Understand conceptual development of zero, first and second order systems.
3. Describe the working principles in the measurement of field and derived quantities.
4. Analyze sensing requirements for measurement of thermo-physical properties, radiation properties of surfaces, and vibration.

Unit-I: INTRODUCTION

Introduction – Generalized measurement system – standards – calibration – Dynamic measurements – System response – Distortion – Impedance matching – Fourier analysis – Experiment planning – causes and types of errors – Error analysis – Uncertainty analysis – Evaluation – Statistical analysis of experimental data – Probability distribution

Unit-II: DATA TRANSMISSION & TRANSDUCERS

Data Acquisition – Data transmission – data storage and display Variable resistance transducers, capacitive transducers, piezoelectric transducers, photoconductive transducers, photovoltaic cells, ionization transducers, Hall effect transducers

Unit-III: ENGINEERING INSTRUMENTS

Dynamic response considerations, Bridgman gauge, McLeod gauge, Pirani thermal conductivity gauge, Knudsen gauge, Alphatron.

Unit-IV: MEASUREMENT OF TEMPERATURE & FLOW

Flow measurement by drag effects; hot-wire anemometers, magnetic flow meters, flow visualization methods, interferometer, Laser Doppler anemometer. Temperature measurement by mechanical effect, temperature measurement by radiation, transient response of thermal systems, thermocouple compensation, temperature measurements in high- speed flow.

Unit-V: MEASUREMENT OF THERMAL CONDUCTION & RADIATION

Thermal conductivity measurement of solids, liquids, and gases, measurement of gas diffusion, convection heat transfer measurements, humidity measurements, heat-flux meters. Detection of thermal radiation, measurement of emissivity, reflectivity and transmissivity, solar radiation measurement.

Text Books:

1. J. P. Holman, Experimental Methods for Engineers, 7th Edition, Tata McGraw-Hill 2001.
2. T.G. Beckwith, J.H. Lienhard V, R. D. Marngoni, Mechanical Measurements, 5th Edition, Pearson Education, 2010.E.O. Doebelin, Measurement systems, Application and Design, 5th Edition, Tata McGraw-Hill, 2008

PROFESSIONAL ELECTIVE-II

PROFESSIONAL ELECTIVE – II
ADVANCED I.C. ENGINES

I Year / I Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62119	PEC	3	0	0	3	40	60	100

Course objectives: The course is intended to

1. Analyze engine cycles and the factors responsible for making the cycle different from the Ideal cycle.
2. Apply principles of thermodynamics, fluid mechanics, and heat transfer to influence the engine's performance.
3. Understand the delay period and fuel injection system.
4. Become aware of the relevance of environmental and social issues on the design process of internal combustion engines

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

1. Apply thermodynamic analysis to IC engines and describe combustion phenomena in spark ignition and compression ignition engines.
2. Describe the working of major systems used in conventional and modern engines.
3. Summarize the methods used to improve engine performance and estimate performance parameters.
4. Describe engine emission control techniques and implement viable alternate fuels.
5. Analyze the heat transfer in engines and modern trends

UNIT – I: INTRODUCTION

Introduction – Historical Review – Engine Types – Design and operating Parameters.
Cycle Analysis: Thermo-chemistry of Fuel – Air mixtures, properties – Ideal Models of Engine cycles – Real Engine cycles - differences and Factors responsible for – Computer Modeling.

UNIT – II: GAS EXCHANGE PROCESS & CHARGE MOTION

Gas Exchange Processes: Volumetric Efficiency – Flow through ports – Supercharging and Turbo charging.
Charge Motion: Mean velocity and Turbulent characteristics – Swirl, Squish – Pre-chamber Engine flows.

UNIT – III: COMBUSTION IN SI & CI ENGINES

Engine Combustion in SI Engines: Combustion and Speed – Cyclic Variations – Ignition – Abnormal combustion Fuel factors, MPFI, SI engine testing.

COMBUSTION IN CI ENGINES: Essential Features – Types of Cycle. Pr. Data – Fuel Spray Behavior – Ignition Delay – Mixing Formation and control, Common rail fuel injection system.

UNIT – IV: POLLUTION FORMATION & CONTROL

Pollutant Formation and Control: Nature and extent of problems – Nitrogen Oxides, Carbon monoxide, unburnt Hydrocarbon and particulate – Emissions – Measurement – Exhaust Gas Treatment, Catalytic converter, SCR, Particulate Traps, Lean, NOx, Catalysts.

UNIT – V: ENGINE HEAT TRANSFER & MODERN TRENDS
Engine Heat Transfer: Importance of heat transfer, heat transfer and engine energy balance, Convective heat transfer, radiation heat transfer, Engine operating characteristics. Fuel supply systems for S.I. and C.I engines to use gaseous fuels like LPG, CNG and Hydrogen. **Modern Trends in IC Engines:** Lean Burning and Adiabatic concepts, Rotary Engines, Modification in I.C engines to suit Bio – fuels, HCCI and GDI concepts.
TEXT BOOKS: 1. I.C. Engines by V. Ganesan, TMH 2. I.C. Engines Fundamentals by Heywood, TMH
REFERENCE BOOKS: 1. I.C. Engines by G.K. Pathak & DK Chevan, Standard Publications 2. Dual-Fuel Diesel Engines by Ghazi A. Karim, CRC Press 3. I.C. Engines by RK Rajput, Laxmi Publications 4. Internal Combustion Engines by S.S. Thipse, Jaico 5. Computer Simulation of C.I. Engine Process by V. Ganesan, University Press 6. Fundamentals of IC Engines by HN Gupta, PHI, 2nd edition 7. I.C. Engines by Fergnson, Wiley. 8. The I.C. Engine in theory and Practice Vol. I /Teylor /IT Prof. And Vol. II. Computer Simulation of Spark-Ignition Engine Processes by V. Ganesan, Universities Press

PROFESSIONAL ELECTIVE – II
GAS TURBINES & JET PROPULSION

I Year / I Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62120	PEC	3	0	0	3	40	60	100

Course Objectives:

1. To present a detailed understanding of the components of a typical turbojet engine.
2. To demonstrate the physical processes involved in the operation of turbojets.
3. To teach students methods to size and design components as well as perform integration of an engine system.
4. Understand of thermodynamic cycles of jet engines.
5. Analyze jet engines; determine propulsion efficiency and design inlets and nozzles.

Course Outcomes:

1. Understand construction and design features of gas turbines as used for power generation.
2. Explore to thermodynamics and fluid mechanics component for enhancing the efficiency and effectively of gas turbines
3. Develop skills in problem solving for aircraft propulsion systems, in particular gas turbine engines.
4. Analyse the performance enhancement approaches for jet propulsion engines
5. Describe the basic concepts of rocket propulsion.

UNIT-I: INTRODUCTION

Introduction, Cycles, Actual and Ideal cycles, merits and demerits, Performance characteristics and improvement.

UNIT-II: DYNAMICS IN COMPRESSORS

Gas dynamics, Centrifugal, axial and mixed flow compressor, principles and characteristics, Turbine construction.

UNIT-III: MATERIAL AND OTHER SYSTEMS

Blade materials, manufacturing techniques, blade fixing, Problems of high temperature operation, blade cooling, practical air-cooled blades Combustion Systems, various fuels and fuel systems,

UNIT-IV: JET PROPULSION

Theory of jet propulsion, Jet propulsion cycles and their analysis, thrust equation, parameters affecting performance, thrust power and propulsive efficiency, Operating principle and cycle analysis of ramjet, turbojet, turbofan and turboprop engines. thrust augmentation, environmental considerations and applications

UNIT-V: ROCKET ENGINES

Types of rocket engines, propellants & feeding systems, ignition and combustion, theory of rocket propulsion, performance study, staging, terminal and characteristic velocity, space flights

Text Books:

1. V. Ganesan, “Gas Turbines”, Tata McGraw Hill, 2003

Reference Books:

1. H Cohen, GFC Rogers and HIH Saravanamuttoo, “Gas Turbine Theory”, Pearson Education, 2000.
2. S.M.Yahya “Turbines, Compressors and Fans”, Tata McGraw Hill, 1992.
3. Vincent “The theory and design of Gas Turbine and Jet Engines”, McGraw Hill, 1950.

PROFESSIONAL ELECTIVE – II
NANO FLUIDS

I Year / I Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62121	PEC	3	0	0	3	40	60	100

Course Objectives:

The course is intended to introduce the application of nanotechnology in different applications related to thermal engineering

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

1. Understand the types of nano fluids and the effect of volume concentration and temperature on thermo physical properties of nano fluids
2. Estimate thermal conductivity and specific heat of nano fluids.
3. Determine Nusselt number and friction factor of various nano fluids using correlations
4. Apply nano fluids in industrial heat exchanger and study their effect in obtaining higher thermal efficiency and saving energy
5. Apply nano fluids in heating and cooling processes

UNIT- I: INTRODUCTION

Introduction to nanofluids, nanostructure materials, base fluids, dispersion, sonication and stable suspension. Various types of nanofluids-volumetric concentration. Thermo physical properties: Density; principles of measurement and apparatus. Theoretical equations and new empirical correlations to determine the density of different nanofluids. Viscosity: principles of measurement and apparatus. Andrade's and other theoretical equations and new empirical correlations to determine the viscosity of different nanofluids. Effect of volumetric concentration and temperature. Effect of subzero temperature on nanofluid viscosity.

UNIT- II: THERMAL CONDUCTIVITY

Thermal conductivity: principles of measurement and apparatus. Hamilton-Crosser and other theoretical equations and new empirical correlations to determine the thermal conductivity of different nanofluids. Effect of volumetric concentration and temperature. Effect of Brownian motion on enhancing the thermal conductivity. Specific heat: principles of measurement and apparatus. Buongeorno's thermal equilibrium equation and other theoretical equations and new empirical correlations to determine the specific heat of different nanofluids. Effect of volumetric concentration and temperature.

UNIT- III: DIMENSIONLESS NUMBERS

Combined effects of thermos physical properties of nanofluids on the thermal diffusivity, the Prandtl number, the Reynolds number and the Nusselt number. Basic understanding of their effects on frictional loss and Heat transfer. Convective heat transfer: Single-phase fluid equations, laminar flow, entry length and fully developed friction factor and heat transfer coefficient. Graetz number effect in the entry region. Correlations for friction factor and Nusselt number for nanofluids. Turbulent flow: Single phase fluid fully developed flow Dittus-Boelter and Glienilski equations. Blasius and other turbulent friction factor correlations. Their comparison with nanofluids data. New correlations for turbulent friction factor and Nusselt

number for nanofluids.

UNIT- IV: HEAT EXCHANGERS FOR NANOFLUIDS

Principles of measurement and apparatus for the nanofluid convective heat transfer coefficient. Recent empirical relations for convection coefficient of various types of nanofluids. Effect of particle Peclet number. Effect of volumetric concentration. Application of nanofluids to various types of industrial heat exchangers. Heating capacity, mass flow, heat exchanger surface area, LMTD and pumping power for nanofluids versus conventional heat transfer fluids.

UNIT V: APPLICATIONS OF NANOFLUIDS

Application to building heating and cooling Comparison of nanofluids performance with glycol solution in hydronic coils. Application to automobile radiators. Comparison of the performance of nanofluids under arctic and sub

TEXT BOOKS:

1. Microscale and Nanoscale Heat Transfer by C. Sobhan and G. Peterson, First edition, CRC Press.
2. Handbook of Nanostructured Materials and Nanotechnology by H.S.Nalwa, I edition, Vol. I and II, American Scientific Publishers.
3. Springer Handbook of Nanotechnology by Bharat Bhushan, 1st edition, Springer-Verlag Publication

REFERENCE BOOKS:

1. Text book of Nano Science and Nano Technology by BS Murthy, P. Shankar, Universities Press.
2. Fluid Mechanics by F. M. White, 5th Edition, McGraw-Hill.
3. Heat Transfer by A. Bejan 2nd Edition, John Wiley

PROFESSIONAL ELECTIVE-III

PROFESSIONAL ELECTIVE-III
FINITE ELEMENT ANALYSIS

I Year / II Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62122	PEC	3	0	0	3	40	60	100

COURSE OBJECTIVES:

1. To Introduce the basic concepts of the finite element method, the boundary element method
2. To discuss the advantages and limitations of each method
3. To Demonstrate the capabilities of each method on a variety of problems.

COURSE OUTCOMES:

At the end of the course students are able to

1. Understand the background of mathematical equations used for development of modeling software modules to develop the various structural related applications
2. Identify mathematical model for solution of common engineering problems.
3. Solve structural, thermal, fluid flow problems.
4. Use professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer.

UNIT– I: ONE DIMENSIONAL PROBLEMS

One Dimensional Problems: Formulation of Stiffness Matrix for a Bar Element by the Principle of Minimum Potential Energy, Properties of Stiffness Matrix, Characteristics of Shape Functions, Quadratic shape functions.

Analysis of Trusses: Derivation of Stiffness Matrix for Trusses, Stress and strain Calculations, Calculation of reaction forces and displacements.

Analysis of Beams: Derivation of Stiffness matrix for two noded, two degrees of freedom per node beam element, Load Vector, Deflection, Stresses, Shear force and Bending moment, Problems on uniform and stepped beams for different types of loads applied on beams.

UNIT– II: TWO DIMENSIONAL PROBLEMS

Finite element – formulation of 2D Problems: Derivation of Element stiffness matrix for two-dimensional CST Element, Derivation of shape functions for CST Element, Elasticity Equations, constitutive matrix formulation, Formulation of Gradient matrix. Two dimensional Isoparametric Elements and Numerical integration.

Finite element – formulation of 3D problems: Derivation of Element stiffness matrix for Tetrahedron Element, Properties of Shape functions for 3D Tetrahedral Element, Stress-Strain Analysis for 3D Element, Strain Displacement for Relationship Formulation.

UNIT– III: STEADY STATE HEAT TRANSFER
Steady state heat transfer analysis: One Dimensional Finite Element analysis of fin and composite slabs. **Two-dimensional steady state heat transfer problems:** Derivation of Thermal Stiffness matrix for 2D heat transfer problems-CST, Derivation of thermal force vector for 2D heat transfer problems. **Dynamic Analysis**: Formulation of mass matrices for uniform bar and beam Elements using lumped and consistent mass methods, Evaluation of Eigen values and Eigen vectors for a stepped bar and beam Problems.
UNIT– IV: NON LINERAR ANALYSIS
Plate Bending: Introduction – Plate behavior – C^1 (Kirchhoff) Plate elements – C^0 (Mindlin) Plate elements – Mindlin beam – More devices for C^0 Plate elements – Boundary conditions - Analytical problems. **Nonlinear finite element of solids**: Material Nonlinearities, objective rates, nonlinear elasticity, Plasticity, viscoplasticity, viscoelasticity
UNIT–V: BOUNDARY ELEMENT METHODS
Boundary Element Method: Potential Problems: Introduction, boundary Element Approach-Fundamental solution. Numerical Implementation - Determination of Ci, Final Relation, Three-dimensional analysis, tackling kernel singularity. **Boundary Element Formulation for Electrostatic Problems:** Introduction, Basic Relation-Boundary condition, other relations. Discretization and Matrix Formulation – Determination of term $C(p)_m$.
TEXT BOOKS: 1. Finite and Boundary Element Methods in Engineering by O.P. Gupta, Oxford & IBH Publishing Co. Pvt. Ltd 2. The finite element methods in Engineering by S.S. Rao, Elsevier, 4th edition
REFERENCE BOOKS: 1. Finite Element Methods by Alavala, PHI. 2. Introduction to Finite Elements in Engineering by Tirupathi K. Chandrupatla and Ashok D. Belagundu. 3. An Introduction to Finite Element Methods by J. N. Reddy, Mc Graw hill 4. The Finite element method in engineering science by O.C. Zienkowitz, Mc Graw hill. 5. Concepts and Applications of Finite Element Analysis by Robert Cook, Wiley

PROFESSIONAL ELECTIVE-III
OPTIMIZATION TECHNIQUES & APPLICATIONS

I Year / II Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62123	PEC	3	0	0	3	40	60	100

COURSE OBJECTIVES:

1. Numerical optimization techniques for single variable and multi variable non- linear optimization problems.
2. Sensitivity analysis on LPP queuing
3. Simulation of annexing problem & inventory problem.
4. Geometry cutting plane method & branch bound method for linear IPP.
5. Meaning of stochastic programming problem simple problems for finding mean variance of random variables chance constrained algorithm.
6. Formulation of GP model and solving it using arithmetic geometric inequality theorem.
7. State of art nontraditional optimization technique, namely genetic algorithm simulated annealing & particle swarm optimization.

COURSE OUTCOMES:

1. Based on the type of optimization problem like single variable or multivariable,
2. Make sensitivity analysis to study effect of changes in parameters of LPP on the optimal solution without reworking.
3. Simulate the system to estimate specified performance measures.
4. Solve integer programming problem by either geometry cutting plane algorithm or branch band method.
5. Apply chance constrained algorithm and solve stochastic linear programme.
6. Formulate GP model and solve it.
7. Solve given optimization problem by genetic algorithm or simulated annealing or PSO.

UNIT- I: SINGLE VARIABLE NON-LINEAR UNCONSTRAINED OPTIMIZATION

Single Variable Non-Linear Unconstrained Optimization: Elimination methods: Uni-Model function-its importance, Fibonacci method & Golden section method. Interpolation methods: Quadratic & Cubic interpolation methods.

UNIT- II: MULTI VARIABLE NON-LINEAR UNCONSTRAINED OPTIMIZATION

Multi variable non-linear unconstrained optimization: Direct search methods – Univariant method, Pattern search methods – Powell's, Hook -Jeeves, Rosenbrock search methods. Gradient methods: Gradient of function& its importance, Steepest descent method, Conjugate direction methods: Fletcher-Reeves method & variable metric method.

UNIT- III: LINEAR PROGRAMMING AND SIMULATION
Linear Programming – Formulation, Simplex method & Artificial variable optimization techniques: Big M & Two-Phase methods. Sensitivity analysis: Changes in the objective coefficients, constants& coefficients of the constraints. Addition of variables, constraints. Simulation – Introduction – Types- steps – applications: inventory & queuing – Advantages and disadvantages
UNIT- IV: INTEGER AND STOCHASTIC PROGRAMMING
Integer Programming- Introduction – formulation – Geometry cutting plane algorithm – Zero or one algorithm, branch and bound method Stochastic Programming: Basic concepts of probability theory, random variables- distributions-mean, variance, correlation, co variance, joint probability distribution. Stochastic linear programming: Chance constrained algorithm.
UNIT- V: GEOMETRIC PROGRAMMING
Geometric Programming: Polynomials – Arithmetic - Geometric inequality – unconstrained G.P-constrained G.P (≤ type only) Non-Traditional Optimization Algorithms: Genetics Algorithm-Working Principles, Similarities and Differences between Genetic Algorithm & Traditional Methods. Simulated Annealing- Working Principle-Simple Problems. Introduction to Particle Swarm Optimization (PSO) (very brief)
Text Books:
1. Optimization theory & Applications by S. S. Rao, New Age International. 2. Optimization for Engineering Design by Kalyanmoy Deb, PHI
Reference Books:
1. Operations Research by S. D. Sharma 2. Operation Research by H. A. Taha, TMH 3. Optimization in operations research by R. L Rardin 4. Optimization Techniques by Benugundu & Chandraputla, Pearson Asia. 5. Optimization Techniques theory and practice by M. C. Joshi & K. M. Moudgalya, Narosa Publications.

PROFESSIONAL ELECTIVE-III
UTILIZATION OF SOLAR ENERGY

I Year / II Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62124	PEC	3	0	0	3	40	60	100

COURSE OBJECTIVES:

1. Understand basic terminology applicable to solar energy study
2. Create Awareness on solar cells and PV technology
3. Explore to solar instruments /devices for utilization of solar energy
4. Discuss the utilization of solar energy in building and industry applications

Course Outcomes: After successful completion of this course, students shall be able to;

1. Understand and learn the basic knowledge of tracking the Sun for Solar Energy Utilization
2. Explore to different techniques for Solar Energy Conversion into useful Energy i.e. Electrical Energy Thermal Energy etc.
3. Explain the working of different Instruments/Devices used for Convert/Measuring Solar Energy
4. Elaborate Designing concept of different Solar Thermal Devices for building applications i.e. Different Thermal Collectors, Their Orientations etc.
5. Analyse the solar heating / cooling and storage concepts with regard to industrial Applications

Unit-I: SOLAR RADIATION

Solar Radiation: Irradiation and Peak Sun Hours, Solar Radiation Data, Sun path Diagram, Defining the Position of the Sun, Sun Tracking, Solar Altitude, Geometric Effects, Tilting Solar Modules

Unit-II: SOLAR CELL AND SOLAR LIGHTING

PV / Solar Cell and Solar Lighting: Introduction, Characteristics of a Solar Cell, Power Characteristics of a Solar Cell, Fill factor and Equivalent Solar cell Circuit, STC and NOCT, Factors Which Affect the Performance of Solar Cells, Types of Solar Cells, Different PV Technology, solar lanterns, home lighting systems, solar lanterns, solar PV pumps.

Unit-III: SOLAR THERMAL APPLICATIONS

Solar thermal Applications: Solar collectors & its types-Flat plate, Concentrating solar collectors, Evacuated Tube Collector, advanced collectors and solar concentrators, Collector Efficiency, solar water heating System, solar cooking, solar drying, , solar thermal power generation.

Unit-IV: SOLAR BUILDING APPLICATIONS

Solar Building Applications: Solar heating, cooling & its types, Active and Passive heating and cooling of buildings

Unit-V: SOLAR STORAGE & INDUSTRIAL APPLICATIONS

Solar Storage & Industrial Applications: Solar Energy Storage, Industrial process heat systems, Low Temperature application

Text Books

1. S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, second edition, Tata McGraw-Hil, New Delhi, 1996.
2. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, second edition, John Wiley, New York, 1991.

Reference Books:

1. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.
2. M. S. Sodha, N. K. Bansal, P. K. Bansal, A. Kumar and M. A. S. Malik, Solar Passive Building: science and design, Pergamon Press, New York, 1986.

PROFESSIONAL ELECTIVE-IV

PROFESSIONAL ELECTIVE-IV
COGENERATION & WASTE HEAT RECOVERY SYSTEMS

I Year / II Semester: M. Tech. THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62125	PEC	3	0	0	3	40	60	100

COURSE OBJECTIVES:

1. To detail on the importance of Total Energy Concept, its advantages, cost effectiveness
2. To analyze the basic energy generation cycles
3. To detail about the concept of cogeneration, its types and probable areas of applications
4. To study the significance of waste heat recovery systems and carry out its economic analysis

Course outcomes: The student can

1. Explain the basics of cogeneration and Waste heat recovery
2. Apply the concepts of Cogeneration technologies and functions of its components
3. Analyse the issues and applications of Co-generation technologies
4. Choose the appropriate criteria for waste heat recovery systems and its components
5. Understand the Economic aspects of cogeneration and Waste heat recovery

UNIT-I INTRODUCTION

INTRODUCTION – principles of thermodynamics – cycles – topping – bottoming – combined cycle – organic Rankine cycles – performance indices of cogeneration systems – waste heat recovery – sources and types – concept of tri generation.

UNIT-II CO-GENERATION TECHNOLOGIES

CO-GENERATION TECHNOLOGIES Configuration and thermodynamic performance – steam turbine co-generation systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: fuel cell, Stirling engines etc.,

UNIT-III ISSUES AND APPLICATIONS OF COGENERATION TECHNOLOGIES

ISSUES AND APPLICATIONS OF COGENERATION TECHNOLOGIES Cogeneration plants electrical interconnection issues – utility and cogeneration plant interconnection issues – applications of cogeneration in utility sector – industrial sector – building sector – rural sector – impacts of cogeneration plants – fuel, electricity and environment.

UNIT-IV WASTE HEAT RECOVERY SYSTEMS

WASTE HEAT RECOVERY SYSTEMS Selection criteria for waste heat recovery technologies – recuperators – Regenerators – economizers – plate heat exchangers – thermic fluid heaters – Waste heat boilers – classification, location, service conditions, design Considerations – fluidized bed heat exchangers – heat pipe exchangers – heat pumps – sorption systems.

UNIT-V	ECONOMIC ANALYSIS

ECONOMIC ANALYSIS Investment cost – economic concepts – measures of economic performance – procedure for economic analysis – examples – procedure for optimized system selection and design – load curves – sensitivity analysis – regulatory and financial frame work for cogeneration and waste heat recovery systems.

Text Books:

1. Charles H. Butler, Cogeneration, McGraw Hill Book Co.,
2. EDUCOGEN – The European Educational tool for cogeneration, Second Edition, 2001

Reference Books:

1. Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford, 1987.
2. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London, 1963.
3. Seagate Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983.
4. De Nevers, Noel, Air Pollution Control Engineering, Mc Graw Hill, New York, 1995.

PROFESSIONAL ELECTIVE-IV
RENEWABLE ENERGY SOURCES

I Year / II Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62126	PEC	3	0	0	3	40	60	100

COURSE OBJECTIVES: The course is intended to

1. To provide an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application.
2. To explore society's present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy.
3. To focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, and hydro, Energy conservation methods.

COURSE OUTCOMES:

At the successful completion of course, the student is expected to have/be able to:

1. Explain the main sources of energy including Solar energy and their primary applications in Global Context.
2. Describe the challenges and problems associated with the use of solar energy sources and its Economic Evaluation
3. Discuss significance of Wind energy systems and its components with basic working principles.
4. Elaborate the sources of energy from waste by various means such as OTEC, Tidal energy etc.
5. Narrate the importance and potential of geo thermal energy and MHD power generation

UNIT-I: INTRODUCTION

Introduction: Overview of the course. Classification of energy resources, energy scenario in the world and India

Basic sun-earth relationships: Definitions. Celestial sphere, altitude-azimuth, declination-hour angle and declination-right ascension coordinate systems for finding the position of the sun, celestial triangle and coordinates of the sun. Greenwich Mean Time, Indian Standard Time, Local Solar Time, sun rise and sun set times & day length. Numerical problems

Solar radiation: Nature of solar radiation, solar radiation spectrum, solar constant, extra-terrestrial radiation on a horizontal surface, attenuation of solar radiation, beam, diffuse and global radiation. Measurement of global, diffuse and beam radiation. Prediction of solar radiation; Angstrom model, Page model, Hottel's model, Liu and Jordan model etc. Insolation on an inclined surface, angle of incidence, Illustrative problems

UNIT-II: SOLAR THERMAL SYSTEMS & ENERGY CONVERSION
Solar thermal systems: Principle of working of solar water heating systems, solar cookers, solar desalination systems, solar ponds, solar chimney power plant. **Solar concentrating collectors:** Classification of solar concentrators, Basic definitions such as concentration ratio, angle of acceptance etc., Tracking of the sun; description of different tracking modes of a solar collectors and the determination of angle of incidence of insolation in different tracking modes. Illustrative problems **Photovoltaic energy conversion:** Introduction. Single crystal silicon solar cell, i-v characteristics, effect of insolation and temperature on the performance of silicon cells. Different types of solar cells. Modern technological methods of producing these cells. Indian and world photovoltaic energy scenario.
UNIT-III: ENERGY STORAGE & WIND ENERGY
Energy storage: Necessity for energy storage. Classification of methods of energy storage. Thermal energy storage; sensible heat storage, latent heat storage. Reversible chemical reaction storage. Electromagnetic energy storage. Hydrogen energy storage. Chemical battery storage. Pumped hydel energy storage etc. **Wind energy:** Origin of winds, nature of winds, wind data measurement, wind turbine types and their construction, wind-diesel hybrid system, environmental aspects, wind energy programme in India and the world.
UNIT-IV: OCEAN ENERGY & FUEL CELLS
Ocean energy: Ocean thermal energy; open cycle & closed cycle OTEC plants, environmental impacts, challenges, present status of OTEC systems. Ocean tidal energy; single basin and double basin plants, their relative merits. Ocean wave energy; basics of ocean waves, different wave energy conversion devices, relative merits Fuel cells: Introduction, applications, classification, different types of fuel cells such as phosphoric acid fuel cell, alkaline fuel cell, PEM fuel cell, MC fuel cell. Development and performance fuel cells.
UNIT-V: BIOMASS & BIOGAS
Biomass: Introduction, photosynthesis, biofuels, biomass resources, biomass conversion technologies, urban waste to energy conversion, biomass to ethanol conversion, biomass energy scenario in India. Biogas: Biogas production, constant pressure and constant volume biogas plants, operational parameters of the biogas plant Geothermal energy: Origin, applications, types of geothermal resources, relative merits
Text Books:
1. Non-conventional Energy Resources by B. H. Khan, Tata McGraw Hill, New Delhi, 2012. 2. Energy Technology: Non-Conventional, Renewable and Conventional by S. Rao and B. B. Parulekar, Khanna Publishers, 2010.
Reference Books:
1. Solar Energy-Principles of Thermal Collection and Storage by S. P. Sukhatme and J. K. Nayak, TMH, 2008. 2. Solar Energy Thermal Processes by J. A. Duffie and W. A. Beckman, John Wiley, 2010..

PROFESSIONAL ELECTIVE-IV
ENERGY CONSERVATION AND MANAGEMENT

I Year / II Semester: M Tech THERMAL ENGINEERING

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62127	PEC	3	0	0	3	40	60	100

COURSE OBJECTIVES:

.1.To understand the principles of energy conservation
2. To understand thermal insulation & refractors.
3. To know waste heat recovery systems.
4. To gain knowledge about engineering economics.
5. To impart knowledge Energy management programs.

Course Outcomes:

1. Explain the basic concept of energy conservation and its role in energy management.
2. Focus on thermal Insulation & refractors, classification and applications
3. Discuss the energy conservation opportunities in the energy intensive industries by waste heat recovery system
4. Analyze the quantum of electrical energy that can be saved by the use of energy efficient lighting
systems and energy audit parameters
5. understand concept of Project management and energy management Programs

UNIT-I INTRODUCTION

ENERGY CONSERVATION: Rules for efficient energy conservation – technologies for energy conservation – outline of waste heat and material reclamation, load management, alternate energy sources, and energy storage.

UNIT-II THERMAL INSULATION & REFRACTORS

THERMAL INSULATION & REFRACTORS: Heat loss through un-insulated surfaces, effects of insulation on current carrying wires – economic thickness of insulation – critical radius of insulation – properties of thermal insulators – classification of insulation materials – classification of refractors – properties of refractors – criteria for good refractory material – applications of insulating & refractory materials.

UNIT-III WASTE HEAT RECOVERY SYSTEMS

WASTE HEAT RECOVERY SYSTEMS: Guideline to identify waste heat – feasibility study of waste heat – shell and tube heat exchanger – thermal wheel – heat pipe heat exchanger – heat pump – waste heat boilers – incinerators.
HEAT RECOVERY SYSTEMS & HEAT EXCHANGER NETWORKS: Liquid to liquid heat exchangers – gas to liquid heat recovery systems, regenerators, recuperators, rotating regenerators miscellaneous heat recovery methods – selection of materials for heat exchangers – combined radiation and convective heat exchanger, U tube heat exchanger, tube heat exchanger, fluidized bed heat exchanger – economizer

UNIT-IV	ENGINEERING ECONOMICS

ENGINEERING ECONOMICS: Managerial objectives, steps in planning – efficiency of organization- capital budgeting – classification of costs – interest – types – nominal and effective interest rates – discrete and continuous compounding – discounting - time value of money – cash flow diagrams – present worth factor, capital recovery factor, equal annual payments – equivalent between cash flows. ENERGY AUDITING: A definition – objectives – level of responsibility – control of energy – uses of energy – check lists – energy conservation schemes – energy index – cost index – pie charts – sankey diagrams – load profiles – types of energy audits – questionnaire – energy audit of industries – general energy audit – detailed energy audit – energy saving potential.

UNIT-V	ENERGY PROJECT MANAGEMENT

PROJECT MANAGEMENT: Method of investment appraisal – rate of return method, pay back method, net present value method (NPV) – adoption of the methods in energy conservation campaign – types of projects –– propose of project management – classification – role and qualities of project manager – types of budgets - budget committee – budgeting.
ENERGY MANAGEMENT PROGRAMS: Necessary steps of energy management programme – concepts of energy management – general principles of energy management – energy management in manufacturing and process industries – qualities and functions of energy managers – duties of energy manager - language of energy manager – checklist for top management

Text Books:

1. Waste heat recovery systems -D.A. Reay/Pergmon Press
2. Energy Management -W.R. Murphy & G.Mickay, Butterworths

Reference Books:

1. Energy Conservation -P.W.O' Callaghan, Pargamon Press 1981
2. Engineering Heat Audits -C.P. Gupta & Rajendra Prakash, Nechand & amp; Bros.
3. Hand book of energy audits -Albert Thumann, The F.Airmont Press Inc., Atlanta Georgia, 1979.
4. Energy Management Principles -Craig B. Smithm, Pergarmon Press

PROFESSIONAL ELECTIVE-V

PROFESSIONAL ELECTIVE-V
REFRIGERATION & HVAC

II M.Tech. I Semester Thermal Engineering

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62128	PEC	3	0	0	3	40	60	100

COURSE OBJECTIVES:

Students will learn

1. Apply the principles of thermodynamics to analyze different types of refrigeration and HAV
2. To understand the functionality of the major components of the refrigeration and HAV
3. To apply the knowledge in effective refrigeration and HAV systems for better performances in real context
4. Discuss the heating procedure by Air-conditioning process
5. Explain the requirement of ventilation devices/processes

COURS OUTCOMES:

At the end of the course students are able to

1. Differentiate between different types of refrigeration systems with respect to application as well as conventional & unconventional refrigeration systems.
2. Analyse thermodynamically low temperature refrigeration and Vapour absorption refrigeration for evaluation of performance parameters.
3. Apply the air refrigeration principles for different types of Air craft refrigeration systems
4. Elaborate the principles of psychometrics to design the air conditioning heating /cooling loads for industrial applications.
5. explain the requirement of ventilation air, various sources of infiltration air, ventilation and infiltration as a part of cooling load

UNIT-I	VAPOUR COMPRESSION REFRIGERATION

Vapour Compression Refrigeration: Performance of Complete vapor compression system. Actual Vs Ideal cycle - Effect of operating parameters on COP, Components of Vapor Compression System: The condensing unit – Evaporators – Expansion valve – Refrigerants – Properties – ODP & GWP - Load balancing of vapor compression Unit.
Compound Compression: Flash inter-cooling – flash chamber – Multi-evaporator & Multistage systems.

UNIT-II	PRODUCTION OF LOW TEMPERATURE

Production of Low Temperature: Liquefaction system, Liquefaction of gases, Hydrogen and Helium, Cascade System – Applications– Dry ice system.
Vapor absorption system – Simple and modified aqua – ammonia system – Representation on Enthalpy – Concentration diagram.
Lithium – Bromide system Three fluid system – HCOP.

UNIT-III	SOLUTION TECHNIQUES

Air Refrigeration: Applications – Air Craft Refrigeration -Simple, Bootstrap, Regenerative and Reduced ambient systems – Problems based on different systems.
Steam Jet refrigeration system: Representation on T-s and h-s diagrams – limitations and applications.
Unconventional Refrigeration system – Thermo-electric – Vortex tube & Pulse tube – working principles.

UNIT-IV	AIR CONDITIONING

Air Conditioning: Psychometric properties and processes – Construction of Psychometric chart. Requirements of Comfort Air –conditioning – Thermodynamics of human body – Effective temperature and Comfort chart – Parameters influencing the Effective Temperature.
Heating Load Calculations: Summer/ Winter heating load calculation-heat losses through structure-heat losses due to infiltration. Effects of solar radiation and internal heat sources on heating loads. Air Heating System: Classification - gravity warm heating system, forced warm air heating system balancing a warm air heating system, warm air furnaces, air cleaners, humidifiers & De-humidifiers

UNIT-V	AIR CONDITIONING SYSTEMS

Air Conditioning Systems: All Fresh air, Re-circulated air with and without bypass, with reheat systems – Calculation of Bypass Factor, ADP, RSHF, ESHF and GSHF for different systems.
Ventilation: Ventilation and Infiltration: Requirement of ventilation air, various sources of infiltration air, ventilation and infiltration as a part of cooling load. Fans and Blowers: Types, performance characteristics, series and parallel arrangement, selection procedure. Equipments and Controls: Chillers, Condensing units, Cooling coils, bypass factors, humidifiers, dehumidifiers

TEXT BOOKS:

1. Refrigeration & Air Conditioning by C.P. Arora, TMH
2. Refrigeration & Air Conditioning by Arora & Domkundwar, Dhanpat Rai
3. Refrigeration and Air Conditioning by Manohar Prasad

REFERENCE BOOKS:

1. Basic Refrigeration & Air Conditioning by P.N. Ananthanarayanan, McGraw Hill
2. Refrigeration and Air Conditioning by Stoecker, Mc Graw Hill
3. Refrigeration and Air Conditioning by Dr. S.S. Thipse, Jaico
4. Refrigeration and Air Conditioning by Jordan & Preister, Prentice Hall
5. Refrigeration and Air Conditioning by Dossat, Mc Graw Hill

PROFESSIONAL ELECTIVE-V
GAS DYNAMICS

II M.Tech. I Semester Thermal Engineering

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62129	PEC	3	0	0	3	40	60	100

COURSE OBJECTIVES:

1. The basic concept and importance of gas dynamics
2. Understand of the Isentropic and non-isentropic flows
3. Interpret the flow pattern in flow and non-flow systems
4. Awareness on two-dimensional flow and related parameters
5. Explore to Unsteady wave motions

Course Outcomes

1. Explain basic concepts of gas dynamics and describe the basic fundamental equations of one-dimensional flow of compressible fluid and isentropic flow of an ideal gas.
2. Analyze the steady one-dimensional is entropic flow, frictional flow and isothermal flow and express the concepts of steady one-dimensional flow with heat transfer.
3. Discuss the effect of heat transfer on flow parameters while passing through nozzles and diffusers
4. Describe the significance two-dimensional flow, impact of Shock waves etc.
5. Infer the salient features of Unsteady wave motions, Incident and reflected expansion waves

UNIT- I: INTRODUCTION

Basic Concepts: Introduction to compressible flow, A brief review of thermodynamics and fluid mechanics, Integral forms of conversion equations, Differential conversion equations, Continuum Postulates, Acoustic speed and Mach number, Governing equation for compressible flows.

UNIT – II: ONE- DIMENSIONAL COMPRESSIBLE FLOW

One- dimensional compressible flow: One dimensional flow concepts, Isentropic flows, Stagnation/ Total conditions, Characteristics speeds of gas dynamics, Dynamic pressure and pressure coefficients, Normal Shock waves, Rankine-Hugonoit equations, Rayleigh flow, Fanno flow, Crocco' theorem.

UNIT – III: QUASI-ONE DIMENSIONAL FLOWS

Governing equations, Area velocity relations, Isentropic flow through variable-area ducts, Convergent divergent (or De Laval) nozzles, Over-expanded and under expanded nozzle, Diffusers.

UNIT- IV: TWO- DIMENSIONAL FLOW

Oblique shock wave and its governing equations, e-B-M relations, The Hodograph and Shock polar, Supersonic flow over wedges and cones, Mach line, Attached and Detached shock, Reflection and Interaction of oblique shock waves, Supersonic flow over convex and concave corners, Approximation of continuous expansion waves by discrete waves.

UNIT- IV: TWO- DIMENSIONAL FLOW
Oblique shock wave and its governing equations, e-B-M relations, The Hodograph and Shock polar, Supersonic flow over wedges and cones, Mach line, Attached and Detached shock, Reflection and Interaction of oblique shock waves, Supersonic flow over convex and concave corners, Approximation of continuous expansion waves by discrete waves.
REFERENCES: 1. Gas Dynamics-S.M. Yahya 2. Gas Dynamics- Radha Krishnan 3. Compressible Fluid Dynamic – B K Hodge, Keith Koenig, Pearson Publications, I edition 4. Gas Dynamics- Zucker. 5. Dynamics and Thermodynamics of compressible fluid flow (Vol.: I, II)-Ascher H. Shapiro 6. Elements of Gas dynamics -H. W. Liepmann, A. Roshko 7. Fundamentals of Gas Dynamics-V. Babu 8. Modern compressible flow – John.D. Anderson, Jr.

PROFESSIONAL ELECTIVE-V
EQUIPMENT DESIGN FOR THERMAL SYSTEMS

II M.Tech. I Semester Thermal Engineering

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62130	PEC	3	0	0	3	40	60	100

COURSE OBJECTIVES: The course is intended to

- Design and analyze the heat exchangers parallel flow, counter flow, multi pass and, cross flow heat exchanger
- Design and analyze the Shell and tube heat exchanger
- Enabletocarryouttheperformanceofheatexchangerwiththeextendedsurfaces.
- Design and analyze the cooling towers.

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

1) Understand the physics and the mathematical treatment of typical heat exchangers.
2) Apply LMTD and Effectiveness methods in the design of heat exchangers and analyze the importance of LMTD approach over AMTD approach.
3) Analyze the performance of double-pipe counter flow (hair-pin) heat exchangers.
4) Design and analyze the shell and tube heat exchanger.
5) Understand the fundamental physical and mathematical aspects of boiling and condensation.

UNIT-I: CLASSIFICATION OF HEAT EXCHANGERS

CLASSIFICATION OF HEAT EXCHANGERS: Introduction, Recuperation & regeneration, Tabular heat exchangers, Double pipe, shell & tube heat exchanger, Plate heat Exchangers, Gasketed plate heat exchanger. Spiral plate heat exchanger, Lamella heat exchanger, Extended surface heat exchanger, Plate in and Tubular fin.

Basic Design Methods of Heat Exchanger: Introduction, Basic equations in design, Overall heat transfer coefficient, LMTD method for heat exchanger analysis, Parallel flow, Counter flow. Multipass, cross flow heat exchanger design calculations:

UNIT-II: DOUBLE PIPE HEAT EXCHANGER:

DOUBLE PIPE HEAT EXCHANGER: Film coefficient for fluids in annulus, fouling factors, Calorific temperature, Average fluid temperature, The calculation of double pipe exchanger, Double pipe exchangers in series parallel arrangements.

Shell &Tube Heat Exchangers: Tube layouts for exchangers, Baffle heat exchangers, Calculation of shell and tube heat exchangers, Shell side film coefficients, Shell side equivalent diameter, The true temperature difference in a 1-2 heat exchanger. Influence of approach temperature on correction factor. Shell side pressure drop, Tube side pressure drop, Analysis ofperformanceof1-2heatexchangeranddesignofshell&tubeheatexchangers, Flow arrangements for increased heat

recovery, the calculation of 2-4exchangers.

UNIT-III: CONDENSATION OF SINGLE VAPOURS:

CONDENSATION OF SINGLE VAPOURS: Calculation of horizontal condenser, Vertical condenser, De-Super heater condenser, Vertical condenser-sub-Cooler, Horizontal Condenser- Subcooler, Vertical reflux type condenser. Condensation of steam.

UNIT-IV: VAPORIZERS,EVAPORATORSANDREBOILERS

VAPORIZERS, EVAPORATORS AND REBOILERS: Vaporizing processes, Forced circulation vaporizing exchanger, Natural circulation vaporizing exchangers, Calculations of are boiler. Extended Surfaces: Longitudinal fins. Weighted fin efficiency curve, Calculation of a Double pipe fin efficiency curve. Calculation of a double pipe finned exchanger, Calculation of a longitudinal fin shell and tube exchanger.

UNIT-V: DIRECTCONTACTHEATEXCHANGERS:

DIRECT CONTACT HEAT EXCHANGERS: Cooling towers, relation between wet bulb & dew bulb temperatures, calculation of cooling tower performance.
Heat Pipe: Gravity assisted thermo-syphans, micro heat pipes, pulsating heat pipes, loop heat pipe operation & working principles.

Text Books:

1. Process Heat Transfer by D.Q. Kern, TMH
2. Heat Exchanger Design by A.P. Fraasand M.N.Ozisick, John Wiely & sons, NewYork.

Reference Books:

1. Cooling Towers by J.D. Gurney and I.A. Cotter, Maclaren.
2. Heat Pipe Science & Technology, Amir Faghri, Taylor & Francis.
3. Heat Pipe Technology and Applications by J.P Peterson, Johnwiky & sons.

AUDIT COURSES-I

AUDIT COURSE-I
ENGLISH FOR RESEARCH PAPER WRITING

I M.Tech. I Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B6AC01	MC	2	0	0	0	40	60	100

COURSE OBJECTIVES:

Students will be able to:

1. Understand that how to improve your writing skills and level of readability.
2. Learn about what to write in each section.
3. Understand the skills needed when writing a Title.

COURSE OUTCOMES:

Students will be able to:

1. Reflect on their previous writing experiences and enhance their current and future learning
2. Interpret, summarize and critique academic texts.
3. Gather, evaluate and synthesize information from different academic sources
4. Use a process writing approach: from planning to drafting and revising, to create different genres of academic texts
5. Identify good academic writing practices and adopt such practices to maintain academic honesty and avoid plagiarism during the writing process

UNIT-I	PLANNING AND PREPARATION

Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT-II	STRUTURE OF THE PAPER

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT-III	KEY SKILLS

Key skills are needed when writing a Title; key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

UNIT-IV	RESULTS AND DISCUSSION

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	
UNIT-V	**SUBMISSION**
Useful phrases, how to ensure paper is as good as it could possibly be the first - time submission	

Text Books:

1. Goldbort R (2006) Writing for Science, Yale University Press.
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.

Reference Books:

1. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book .
2. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

AUDIT COURSE-I
SANSKRIT FOR TECHNICAL KNOWLEDGE

I M.Tech. I Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B6AC02	MC	2	0	0	0	40	60	100

COURSE OBJECTIVES:

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

COURSE OUTCOMES:

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

UNIT-I	**ALPHABETS IN SANSKRIT**
Alphabets in Sanskrit,	
UNIT-II	**TENSES**
Past/Present/Future Tense, Simple Sentences	
UNIT-III	**ORDER, INTRODUCTION OF ROOTS**
Order, Introduction of roots	
UNIT-IV	**SANSKRIT LITERATURE**
Technical information about Sanskrit Literature	
UNIT-V	**TECHNICAL CONCEPTS OF ENGINEERING**
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics	

Text Books:

1. Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2."Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3."India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

AUDIT COURSE-I
VALUE EDUCATION

I M.Tech I Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B6AC03	MC	2	0	0	0	40	60	100

COURSE OBJECTIVES:

This course will enable students to

1. Understand value of education and self-development
2. Imbibe good values in students
3. Let the should know about the importance of character

COURSE OUTCOMES:

At the end of the course students are able to

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality
4. Develop self-resilience
5. Assess the impact of Ethics and Values on global development

UNIT-I **VALUE ETHICS AND VALUATION**

Values and self-development-Social values and individual attitudes.- Work ethics, Indian vision of humanism
Moral and non-moral valuation. Standards and principles - Value judgments

UNIT-II **CULTIVATION VALUES**

Importance of cultivation of values - Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.
Honesty, Humanity. Power of faith, National Unity - Patriotism. Love for nature, Discipline

UNIT-III **PERSONALITY DEVELOPMENT**

Personality and Behavior Development – Soul and Scientific attitude - Positive Thinking. Integrity and discipline- Punctuality, Love and Kindness - Avoid fault Thinking - Free from anger, Dignity of labour – Universal brotherhood and religious tolerance - True friendship- Happiness Vs suffering, love for truth- Aware of Self-destructive habits- Association and Cooperation - Doing best for saving nature

UNIT-IV **SELF MANAGEMENT**

Character and Competence-Holy books vs Blind faith - Self-management and Good health.- Science of reincarnation- Equality, Nonviolence, Humility, Role of Women.
All religions and same message- Mind your Mind, Self-control - Honesty, Studying effectively

UNIT-V **IMPACT OF GLOBAL DEVELOPMENT ON ETHICS AND VALUES**

Conflict of cross-cultural influences, mass media, cross-border education, materialistic values, professional challenges and compromise.
Modern Challenges of Adolescent Emotions and behavior; Sex and spirituality: Comparison and competition; positive and negative thoughts.

Text Books:
1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press,New Delhi. 2. Dr Kiruba Charles and V Arul Selvi. “Value Education”, Bookman Publishers
Reference Books:
1. Dr S Arulsamy, “Peace And Value Education”, Bookman Publishers 2. Y K Sharma and Kuldeep S Katoch, “Education For Values, Environment And Human Rights”, Regal Publications.

AUDIT COURSE-I
STRESS MANAGEMENT BY YOGA

I M.Tech. I Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B6AC04	MC	2	0	0	0	40	60	100

COURSE OBJECTIVES:

1. To achieve overall health of body and mind
2. To overcome stress

Course Outcomes: Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

UNIT-I	**PARTS OF YOGA**
Definitions of Eight parts of yoga (Ashtanga)	
UNIT-II	**YAM AND NIYAM**
Yam and Niyam.	
UNIT-III	**DO`S AND DON'T'S IN LIFE**
Do`s and Don't's in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	
UNIT-IV	**ASAN AND PRANAYAM**
Asan and Pranayam	
UNIT-V	**YOGA POSES & TYPES OF PRANAYAM**
i) Various yog poses and their benefits for mind & body ii) Regularization of breathing techniques and its effects-Types of pranayam	

Text Books:

1. 'Yogic Asanas for Group Tarining-Part-I": Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

AUDIT COURSES-II

AUDIT COURSE-II
DISASTER MANAGEMENT

I M.Tech. II Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B6AC05	MC	2	0	0	0	40	60	100

COURSE OBJECTIVES: Students will be able to

1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches,
5. planning and programming in different countries, particularly their home country or the countries they work in

UNIT-I **INTRODUCTION**

Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT-II **REPERCUSSIONS OF DISASTERS AND HAZARDS**

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT-III **DISASTER PRONE AREAS IN INDIA**

Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics

UNIT-IV **DISASTER PREPAREDNESS AND MANAGEMENT**

Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT-V **RISK ASSESSMENT DISASTER RISK**

Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.
Disaster Mitigation:
Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Text Books:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep et. al., (Eds.),"Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi.
3. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi.

AUDIT COURSE-II
CONSTITUTION OF INDIA

I M.Tech. II Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B6AC06	MC	2	0	0	0	40	60	100

COURSE OBJECTIVES:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

COURSE OUTCOMES:

At the end of the course students are able to

1. Have general knowledge and legal literacy and thereby to take up competitive examinations
2. Discuss state and central policies, fundamental duties
3. Explain electoral Process, special provisions
4. Know powers and functions of Municipalities, Panchayats and Co-operative Societies
5. Know engineering ethics and responsibilities.

UNIT-I **INTRODUCTION**

Constitution' meaning of the term,, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

UNIT-II **UNION GOVERNMENT AND ITS ADMINISTRATION, STRUCTUREOF THE INDIANUNION**

Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha.

UNIT-III **STATE GOVERNMENT AND ITS ADMINISTRATION GOVERNOR**

Role and Position, CM and Council of ministers, State Secretariat: Organization, Structure and Functions

UNIT-IV **LOCAL ADMINISTRATION DISTRICT'S ADMINISTRATION HEAD**

Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayat raj: Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

UNIT-V **ELECTION COMMISSION**

Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

Text Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Reference Books:
1. ‘Indian Polity’ by Laxmikanth 2. ‘Indian Administration’ by Subhash Kashyap 3. ‘Indian Constitution’ by D.D. Basu 4. ‘Indian Administration’ by Avasti and Avasti

AUDIT COURSE-II
PEDAGOGY STUDIES

I M.Tech. II Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B6AC07	MC	2	0	0	0	40	60	100

COURSE OBJECTIVES:

Students will be able to:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Course Outcomes:

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

UNIT-I INTRODUCTION

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

UNIT-II THEMATIC OVERVIEW

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

UNIT-III EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Evidence on the effectiveness of pedagogical practices, Methodology for the indepth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the scho curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT-IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes

UNIT-V RESEARCH GAPS & FUTURE DIRECTIONS

Research gaps and future directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

Text Books:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

AUDIT COURSE-II
PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

I M.Tech. II Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B6AC08	MC	2	0	0	0	40	60	100

COURSE OBJECTIVES:

Course Objectives:

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Course Outcomes: Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students

UNIT-I **NEETISATAKAM - 1**

- Neetisatakam-Holistic development of personality
- Verses- 19,20,21,22 (wisdom)
- Verses- 29,31,32 (pride & heroism)
- Verses- 26,28,63,65 (virtue)

UNIT-II **NEETISATAKAM – 2**

- Neetisatakam-Holistic development of personality
- Verses- 52,53,59 (dont's)
- Verses- 71,73,75,78 (do's)

UNIT-III **SHRIMAD BHAGWAD GEETA - 1**

- Approach to day to day work and duties.
- Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48,
- Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 18-Verses 45, 46, 48.

UNIT-IV **SHRIMAD BHAGWAD GEETA – 2**

- Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

UNIT-V **SHRIMAD BHAGWAD GEETA - 3**

- Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

TEXT BOOKS/ REFERENCES:

1. Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata.
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

OPEN ELECTIVES

OPEN ELECTIVE
INDUSTRIAL SAFETY

II M.Tech. I Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62135	OEC	3	0	0	3	40	60	100

COURSE OBJECTIVES:

This course will enable the student to understand safety principles, maintenance engineering, methodsof preventing wear and corrosion, fault tracing, periodic and preventive maintenance.

COURS OUTCOMES:

At the end of the course students are able to

1. Focus on tools, techniques and methodologies needed for prevent ion of occurrences of unsafe operations and accidents under different industrial settings.
2. Be equipped with concepts of engineering systems safety, dimensions of engineering systems safety
3. Classify wear and corrosion and explain how to prevent them.
4. Explain elements of fault tracing.
5. Demonstrate the concepts of periodic and preventive maintenance.

UNIT-I INDUSTRIAL SAFETY

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT-II FUNDAMENTALS OF MAINTENANCE ENGINEERING

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance,Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT-III WEAR ,CORROSION AND THEIR PREVENTION

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication,Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT-IV SOLUTIONS OF DIFFERENTIAL EQUATIONS

Variational methods for approximate solutions of differential equations. Standard discrete and continuous distributions like Binomial, Poisson, and Normal, Exponential etc. Central Limit Theorem and its significance. Some sampling distributions like c2, t, F.

UNIT-V INTRODUCTION TO ANOVA

ANOVA: One – way, Two – way with/without interactions, Latin Squares ANOVA technique, Principles of Design Of Experiments, some standard designs such as CRD, RBD, LSD.

Text Books:

1. Ramamurthy. V., Computer Aided Design in Mechanical Engineering., Tata McGraw Hill Publishing Co., 1987.

2. Fundamental Concepts in the Design of Experiments, 5th Ed., by Hicks and Turner.
3. J.B. Doshi, “Differential Equations for Scientists and Engineers”, Narosa, 2010.
4. Peter O'Neil, “Advanced Engineering Mathematics”, Seventh Edition, Cengage Learning, 2012 (Indian Edition).
5. Michael Greenberg, “Advanced Engineering Mathematics”, Second Edition, Pearson Education, 2002 (Indian Edition).

Reference Books:

1. Jennings. A., Matrix Computation for Engineers and Scientists. John Wiley and Sons, 1992.
2. Prem.K.Kythe, Pratap Puri, Michael R.Schaferkotter, Introduction to Partial Differential Equations and Boundary Value problems with Mathematics, CRC Press, 2002.
3. Kreyszig, Erwin, I.S., Advanced Engineering Mathematics, Wiley, 1999.
4. Devore, Jay L., Probability and Statistics for Engineering and the Sciences, 5th edition, Brooks- Cole (1999).

OPEN ELECTIVE
OPERATIONS RESEARCH

II M.Tech. I Semester

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIE	SEE	Total
B62136	OEC	3	0	0	3	40	60	100

COURSE DESCRIPTION:

Operations research (OR) are an analytical method of problem-solving and decision-making that is useful in the management of organizations. In operations research, problems are broken down into basic components and then solved in defined steps by mathematical analysis. This course gives insight of Linear Programming, Transportation Models, Inventory Models, Decision models etc.

COURSE OBJECTIVES:

The objectives of this course are to learn quantitive methods and techniques for effective decisions –making; model formulation and applications that are used in solving business decision problems.

COURSE OUTCOMES:

At the end of course students will be able to

1. Describe types of models and solve linear programming problems.
2. Solve transportation and Network model problems.
3. Analyze inventory models to optimize the cost.
4. Analyze queuing models and apply them for optimization.
5. Solve problems using theory of games and dynamic programming.

UNIT-I	LINEAR MODELS

The Phase Of An Operation Research Study – Linear Programming – Graphical Method– Simplex Algorithm – Duality Formulation – Sensitivity Analysis.

UNIT-II	TRANSPORTATION MODELS AND NETWORK MODELS

Transportation Assignment Models –Traveling Salesman Problem-Networks Models – Shortest Route – Minimal Spanning Tree – Maximum Flow Models –Project Network – CPM And PERT Networks – Critical Path Scheduling – Sequencing Models.

UNIT-III	INVENTORY MODELS

Inventory Models – Economic Order Quantity Models – Quantity Discount Models – Stochastic Inventory Models – Multi Product Models – Inventory Control Models In Practice.

UNIT-IV	QUEUEING MODELS

Queueing Models – Queueing Systems And Structures – Notation Parameter – Single Server And Multi Server Models – Poisson Input – Exponential Service – Constant Rate Service – Infinite Population – Simulation.

UNIT-V	DECISION MODELS
Decision Models – Game Theory– Two Person Zero Sum Games – Graphical Solution- Algebraic Solution– Linear Programming Solution – Replacement Models – Models Based On Service Life – Economic Life– Single / Multi Variable Search Technique – Dynamic Programming – Simple Problems.	
Text Books:	
1. Taha H.A., "Operations Research", Sixth Edition, Prentice Hall Of India, 2003. 2. Shennoy G.V. And Srivastava U.K., "Operation Research For Management", Wiley Eastern, 1994. 3. Bazara M.J., Jarvis And Sherali H., "Linear Programming And Network Flows", John Wiley, 1990.	
Reference Books:	
1. Philip D.T. And Ravindran A., "Operations Research", John Wiley, 1992. 2. Hillier And Libeberman, "Operations Research", Holden Day, 1986 3. Budnick F.S., "Principles Of Operations Research For Management", Richard D Irwin, 1990. 4. Tulsian And Pasdey V., "Quantitative Techniques", Pearson Asia, 2002	

M.Tech in Thermal Engineering

VISION

- The Mechanical Engineering Department endeavors to be recognized globally for outstanding education and research leading to well qualified engineers, who are innovative, entrepreneurial and successful in advanced fields of mechanical engineering to cater the ever changing industrial demands and social needs.

MISSION

- Impart highest quality education to the students to build their capacity and enhancing their skills to make them globally competitive mechanical engineers and successful entrepreneurs.
- Provide the students with academic environment of excellence, state of the art research facilities, leadership, ethical guidelines and lifelong learning needed for a long productive career.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO1: To inculcate qualities for long term learning with ethical and societal responsibilities.

PEO2: To adapt students on sustainability and conservation of resources.

PEO3: To expose the students to current global scenario on cutting edge technologies related to Thermal Engineering.

PROGRAM OUTCOMES (POs):

Engineering Graduates will be able to:

PO1. An ability to independently carry out research / investigation and development work to solve practical problems.

PO2. An ability to write and present a substantial technical report/document.

PO3. Students should be able to demonstrate a degree of mastery over the areas per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1. To train students with in-depth and advanced knowledge to become professionals in the areas of thermal sciences and related fields capable of identifying, analyzing and solving complex problems.

PSO2. To enable graduates to carry out innovative and independent research work in academia/industry to develop thermal systems and processes and to disseminate the knowledge

INSTITUTE VISION STATEMENT

Promote academic excellence, research, Innovation, and entrepreneurial skills to produce graduates with human values and leadership qualities to serve the nation.

INSTITUTE MISSION STATEMENTS

Provide student-centric education and training on cutting-edge technologies to make the students globally competitive and socially responsible citizens.

Create an environment to strengthen the research, innovation and entrepreneurship to solve societal problems.

QUALITY POLICY

We, at MLRIT, are committed to Educate, Enrich and Excel, in imparting Professional Education, by top-quality faculty; who endeavor to mentor the stuents as turn-key solution providers, while striving continually to improve through team work, innovation and research.

GOALS OF MLRIT

Goals of Engineering education at undergraduate / graduate level:

- Equip students with industry – accepted career and life skills
- To create a knowledge warehouse for students
- To disseminate information on skills and competencies that are in use and in demand by the industry.
- To create learning environment where the campus culture acts as a catalyst to student fraternity to understand their core competencies, enhance their competencies and improve their career prospects.
- To provide base for lifelong learning and professional development in support of evolving career objectives, which include being informed, effective, and responsible participants within the engineering profession and in society.
- To prepare students for graduate study in Engineering and Technology.
- To prepare graduates to engineering practice by learining from professional engineering assignments.