ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

M.Tech

THERMAL ENGINEERING

(Applicable for the Batches Admitted from 2019 - 2020)

R-19

NEC
NARASARAOPETA
ENGINEERING COLLEGE
(AUTONOMOUS)

Kotappakonda Road, Yellamanda (P),
Narasaraopet - 522 601, Guntur Dist.,
Andhra Pradesh, INDIA.

Academic Regulations, Course Structure and Syllabus

M.TECH
Mechanical Engineering
(2 Years Program)

NARASARAOPETA ENGINEERING COLLEGE
(AUTONOMOUS)

Kotappakonda Road, Yellamanda (Post), Narasaraopet – 522601, Guntur District, AP
Approved by AICTE, New Delhi & Permanently affiliated to JNTUK, Kakinada, Code: 47,
Accredited by NBA&NAAC, RTA Approved Pollution test Centre, ISO 9001 : 2008 Certified Institution
Phone No. : 08647-239905 **Website:www.nrtec.ac.in**

ACADEMIC REGULATIONS - 2019 FOR M.TECH

(Effective for the students admitted into I year from the Academic Year 2019-20 and onwards)

1. QUALIFICATION FOR ADMISSION

Admission to the above program shall be made subject to eligibility, qualification and specialization as prescribed by the University from time to time.

Admissions shall be made on the basis of merit / rank obtained by the candidates at the qualifying entrance test GATE/PGECET or on the basis of any other order of merit as approved by the Government from time to time.

2. AWARD OF M.TECH. DEGREE

A student will be declared eligible for the award of the M. Tech. Degree, if he fulfils the following academic requirements.

(a) Pursue a course of study for not less than two academic years and not more than four academic years.

(b) The candidate registers for 80 credits and secure all 80 credits.

3. COURSES OF STUDY

The following courses of study are offered at present as specializations in the M.Tech. courses with English as medium of instruction.

S. No.	Specialization Code	Abbreviation
01	06 - DSCE	Digital Systems and Computer Electronics
02	15 - MD	Machine Design
03	21 - TE	Thermal Engineering
04	38 - DECS	Digital Electronics and Communication Systems
05	42 - P&ID	Power and Industrial Drives
06	58 - CSE	Computer Science and Engineering
07	87 - SE	Structural Engineering

And any other course as approved by the authorities from time to time.

4. STRUCTURE OF THE PROGRAMME

Semester	Credits
I M.TECH I SEM	21
I M.TECH II SEM	21
II M.TECH III SEM	38
II M.TECH IV SEM	
TOTAL	80

Each course is normally assigned a certain number of credits as follows:

- 3 credits for 4 lecture periods.
- 3 credits for 6 laboratory periods per week.
- 1 credit for seminar.
- 2 credits for comprehensive viva
- 35 credits for project work.

5. DISTRIBUTION AND WEIGHTAGE OF MARKS

The performance of the candidate in each semester shall be evaluated subject wise, with a maximum of 100 marks for theory / practical / seminar / comprehensive viva on the basis of internal evaluation and end semester examinations.

5.1 THEORY

All theory subjects consisting of 6 units in each subject, the assessment shall be for 40 marks through internal evaluation and 60 marks through external end semester examination of 3 hours duration.

5. 1.a. INTERNAL EVALUATION

The internal evaluation will be based on two cycle tests conducted in each semester. The 40 internal marks will be awarded as 75% of the best cycle and 25% of the least cycle examinations, where each cycle of examination contain
Descriptive test - 30 Marks
Assignment test - 10 Marks

Each descriptive test question paper contains3 questions one from each unit covering syllabus from 3 units (first 3 units for first cycle and the remaining 3 units for second cycle). The student has to answer all the three questions (3X10M=30M).The descriptive examination will be conducted for1½ hour duration.

In Assignment Tests 5 or 6 questions will be declared in the class room at least one week in advance. In the test, two questions (one from each unit) will be given at random to each student and the student has to answer it.
The Assignment Test-1 will be conducted for 10 marks covering the syllabus from 1st& 2ndunits.The Assignment Test-2 will be conducted for 10 marks from 4th& 5th units.

5.1.b. EXTERNAL EVALUATION

The question paper comprises of 8 questions, there should be one from each unit. Student has to answer 5 questions out of 8, each question carry 12marks (5X12=60). The duration of end theory examination is 3 hours.

5.2 PRACTICALS

For practical subjects evaluation is as follows during the semester

5.2.a. INTERNAL EVALUATION

There shall be continuous evaluation during the semester for 40 internal marks. The internal marks shall be awarded as follows:

Record	- 10 Marks
Day-to-day work	- 15 Marks
Internal Lab Test	- 15Marks

5.2.b. EXTERNAL EVALUATION

For practical subjects there shall be an external examination at the end of the semester for 60 marks in the presence of external examiner.

5.3 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the end semester examination and a minimum of 50% of the total marks in the end semester examination and internal evaluation taken together.

5.4 SEMINAR

For seminar, a student under the supervision of a faculty member shall collect the literature on an advanced topic related to his specialization and review the literature then submit it to the department in a report form during the third semester and shall make an oral presentation before the departmental review committee consisting of the supervisor and head of the department / a senior faculty member. There shall be an internal evaluation for 100 marks in the form of viva voce examination and assessment of report and its presentation. There will be NO external evaluation. A candidate shall be deemed to have secured the minimum academic requirement in seminar, if he secures a minimum of 50% of marks in the examination.

If a candidate fails to secure the minimum marks prescribed for successful completion, he has to re-register and he has to submit a fresh report and appear for the evaluation by the committee.

5.5 COMPREHENSIVE VIVA-VOCE

Comprehensive viva voce examination is conducted during the 3rd semester in all the subjects of first & second semesters of the course by a committee consisting of two senior faculty members of the department. There will be NO external evaluation.

A candidate shall be deemed to have secured the minimum academic requirement in seminar, if he secures a minimum of 50% of marks in the examination.

If a candidate fails to secure the minimum marks prescribed for successful completion, he has to re-register and undergo viva voce examination.

5.6 In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.3) he has to re-appear for the end semester examination in that subject.

A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate is less than 50% and has failed in the end examination. In such a case, the candidate must re-register for the subject(s) and secure the required minimum attendance. The candidate's attendance in the re-register subject(s) shall be calculated separately to decide upon his eligibility for writing the end examination in those subject(s). In the event of the student taking another chance, his internal marks and end examination marks in the previous attempt stand cancelled. For re-registration the candidates have to apply to the college by paying the requisite fee and get approval from the authorities before the beginning of the semester in which re-registration is required.

5.7 In case the candidate secures less than the required attendance in any re-registered subject(s), he shall not be permitted to write the End examination in that subject. He shall again re-register the subject when next offered.

5.8 Laboratory examinations must be conducted with two examiners, one of them being the laboratory class teacher or teacher of the respective college and the second examiner shall be appointed by the Principal from the panel of examiners submitted by the respective departments.

5.9 PROJECT WORK

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee.

5.9.1. A Project Review Committee (PRC) shall be constituted with Head of the Department and two other senior faculty members.

5.9.2. Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects, both theory and practical.

5.9.3. After satisfying 5.9.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work for approval. The students can initiate the Project work, only after obtaining the approval from the Project Review Committee (PRC).

5.9.4. If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the Project Review Committee (PRC). However, the Project Review Committee (PRC) shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of project 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.

5.9.5. A candidate shall submit his status report in two stages at least with a gap of 3 months between them.

5.9.6. The work on the project shall be initiated at the beginning of the II year and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis only after successful completion of theory and practical subjects with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. The candidate has to pass all the theory and practical subjects before submission of the Thesis.

5.9.7. Three copies of the Project Thesis certified by the supervisor shall be submitted to the College.

5.9.8. The thesis shall be adjudicated by one examiner selected by the authorities. For this, the HOD of the concerned dept. shall submit a panel of 5 examiners, eminent in that field, with the help of the guide concerned.

5.9.9. If the report of the examiner is not favourable, the candidate shall revise and resubmit the Thesis, in the time frame as decided by the PRC. If the report of the examiner is unfavourable again, the thesis shall be summarily rejected. The candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the authorities.

5.9.10. If the report of the examiner is favourable, viva-voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the thesis. The Board shall jointly report the candidate's work as one of the following: Grade O(Outstanding)/ Grade A(Excellent)/Grade B(Very Good) /Grade C(Good)/ Grade D(Pass)/ Grade F(Fail).

The Head of the Department shall coordinate and make arrangements for the conduct of viva-voce examination.

5.9.11. If the report of the viva-voce is Grade F, the candidate shall retake the viva-voce examination only after three months. If he fails to get a satisfactory report at the second viva-voce examination, the candidate has to re-register for the project and complete the project within the stipulated time after taking the approval from the authorities.

6. ATTENDANCE REQUIREMENTS:

(i) A student shall be eligible to appear for the end examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.

(ii) Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester for genuine medical reasons and shall be approved by a committee duly appointed by the college. A fee stipulated by the college shall be payable towards condonation of shortage of attendance. However the number of condonations is restricted to two for the entire course.

(iii) A student who is short of attendance in a semester may seek re-admission into that semester when offered next time, within 4 weeks from the date of commencement of class work.

(iv) If any candidate fulfils the attendance requirement in the present semester, he shall not be eligible for re-admission into the same class.

7. COURSE PATTERN:

(i) The entire course of study is of two academic years and every year will have TWO Semesters.
(ii) A student is eligible to appear for the end examination in a subject, but absent for it or has failed in the end examinations may appear for that subject in supplementary examinations, when conducted next.
(iii) When a student is detained due to shortage of attendance, he may be re-admitted in to the same semester/year in which he has been detained.

8. METHOD FOR AWARDING OF GRADE POINTS FOR A SUBJECT:

Theory/ Laboratory / Seminar/ Comprehensive viva/ Project (% of marks in a subject)	Corresponding Grade Points	Letter Grade
91 - 100	10	O (Outstanding)
81 - 90	9	A (Excellent)
71 - 80	8	B (Very Good)
61 - 70	7	C (Good)
51 - 60	6	D (Pass)
< 50	0	F (Fail)

9. Criteria for award of grades/division.

9.1 Calculation of Semester Grade Point Average (SGPA)* for semester

The performance of each student at the end of each semester is indicated in terms of SGPA. The SGPA is calculated as given below:

$$\text{SGPA} = \frac{\sum (CR \, X \, GP)}{\sum CR}$$

Where CR= Credits of a subject
GP = Grade Points awarded for a subject
*SGPA is calculated for a candidate who passed all the subjects in that semester.

9.2 Calculation of Cumulative Grade Point Average (CGPA) for Entire Program:

The CGPA is calculated as given below:

$$\text{CGPA} = \frac{\sum (CR \, X \, GP)}{\sum CR}$$

Where CR = Credits of a subject
GP = Grade Points awarded for a subject

- The SGPA and CGPA shall be rounded off to 2 decimal point and reported in the transcripts.
- Equivalent percentage = (CGPA – 0.75) x 10

9.3 Award of Division:

After satisfying the requirements prescribed for the completion of the program, the student shall be eligible for the award of M.Tech Degree and shall be placed in one of the following classes:

CGPA	Class
≥ 7.75	First Class with Distinction (Provided all the subjects should pass in the first attempt)
≥ 6.75	First Class (with subject failures)
≥ 5.75 & < 6.75	Second Class

10. REVALUATION:

1. Student can submit the application for revaluation, along with the prescribed fee for revaluation of his answer script(s) of theory subject(s) as per the notification issued by the Controller of Examinations.

2. The Controller of Examinations shall arrange for revaluation of such answer script(s).

3. An External examiner, other than the first examiner shall revaluate the answer script(s).

11. MINIMUM INSTRUCTION DAYS:

The minimum instruction days for each semester shall be 90 working days.

12. There shall be no branch transfer after the completion of admission process.

13. WITHHOLDING OF RESULTS

If the student has not paid the dues, if any, to the college or if any case of indiscipline is pending against him, the result of such student will be kept withheld. His degree will be withheld in such cases.

14. TRANSITORY REGULATIONS

Discontinued or detained candidates are eligible for readmission as and when next offered.

A candidate, who is detained or discontinued in a semester, on readmission shall be required to do all the subjects in the curriculum prescribed for the batch of students in which the student joins subsequently. However, exemption will be given to those candidates who have already passed such subjects in the earlier semester(s) he was originally admitted into and substitute subjects are offered in place of them as decided by the Board of Studies. However, the decision of the Board of Studies will be final.

14.1 A student who is following JNTUK curriculum and detained due to shortage of attendance at the end of the first semester of first year shall join the autonomous batch of first year first semester. Such students shall study all the subjects prescribed for the batch in which the student joins and considered on par with regular

candidates of Autonomous stream and will be governed by the autonomous regulations.

14.2 A student who is following JNTUK curriculum, detained due to shortage of attendance at the end of the second semester of first year or at the subsequent semesters shall join with the autonomous batch in the appropriate semester. Such candidates shall be required to pass in all the subjects in the program prescribed by the Board of Studies concerned for that batch of students from that semester onwards to be eligible for the award of degree. However, exemption will be given in the subjects of the semester(s) of the batch which he had passed earlier and substitute subjects will be offered in place of them as decided by the Board of Studies. The student has to clear all his backlog subjects up to previous semester by appearing for the supplementary examinations conducted by JNTUK for the award of degree will be sum of the credits up to previous semester under JNTUK regulations and the credits prescribed for the semester in which a candidate seeks readmission and subsequent semesters under the autonomous stream. The class will be awarded based on the academic performance of a student in the autonomous pattern.

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MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT INEXAMINATIONS

- The Principal shall refer the cases of Malpractices in Internal Assessment Test and Semester end examinations to a malpractice prevention committee constituted by him for the purpose. Such committee shall follow the approved levels of punishment. The Principal shall take necessary action against the students based on the recommendations of the committee.
- Any action by the candidate trying to get undue advantage in the performance or trying to help another, or derive the same through unfair means is punishable according to the provisions contained hereunder:

	Nature of Malpractices/ Improper conduct	Punishment
	If the candidate:	
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 he is appearing but has not made use of (material shall include any marks on the body of the candidate 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.
1(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate 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 candidates 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 candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate 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 candidate is to be cancelled and sent to the college.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate 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 candidate is also debarred for two consecutive semesters from classwork and all college examinations. The continuation of the course by the candidate 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 candidate 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 candidate is also debarred for two consecutive semesters from classwork and all college examinations. The continuation of the course by the candidate 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/Assistant – Superintendent /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-incharge 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 candidate(s)has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates 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 of 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 candidate 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 candidate is also debarred for two consecutive semesters from classwork and all college examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess 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 candidate 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 candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6to 8.	Student of the college expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate 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 candidate is also debarred and forfeits the seat. Person(s) who do not belong to the college will be handed over to 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 candidate 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.

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 candidate has appeared 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 college for further action to award suitable punishment.	

OTHER MATTERS:

1. Physically challenged candidates who have availed additional examination time and a scribe during their UG / PGECET examinations will be given similar concessions on production of relevant proof / documents.

2. The Principal shall deal in an appropriate manner with any academic problem which is not covered under these rules and regulations, in consultation with the Heads of the departments and subsequently such actions shall be placed before the Academic Council for ratification. Any emergency modification of regulation, approved in the meetings of the Heads of the departments shall be reported to the Academic Council for ratification.

GENERAL:

1. The academic council may, from time to time, revise, amend or change the regulations, schemes of examinations and / or syllabi.
2. Wherever the words ‘’he’’ ‘’him’’ ‘’his’’, occur in the regulations, they include ‘’she’’, ’’her’’, ’’hers’’.
3. The academic regulation should be read as a whole for the purpose of any interpretation.
4. In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the principal is final.

COURSE: MTECH I SEMESTER

S. No.	SUBJECT NAME	SUBJECT CODE	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	Research Methodology and IPR	19MTE1TH01	3	-	-	40	60	100	3
2	Advanced Thermodynamics	19MTE1TH02	3	-	-	40	60	100	3
3	Advanced Heat & Mass Transfer	19MTE1TH03	3	-	-	40	60	100	3
4	Advanced IC Engines	19MTE1TH04	3	-	-	40	60	100	3
5	**Elective -I**		3	-	-	40	60	100	3
	Gas Dynamics	19MTE1PE05							
	Fuels and Combustion	19MTE1PE06							
	Measurements in Thermal Engineering	19MTE1PE07							
6	**Elective -II**		3	-	-	40	60	100	3
	Finite Element Methods for Thermal Engineering	19MTE1PE08							
	Hydrogen and Fuel Cell Technologies	19MTE1PE09							
	Thermal & Nuclear power plants	19MTE1PE10							
7	Advanced thermal engineering lab	19MTE1LB01	-	-	6	40	60	100	3
	TOTAL		**18**	**-**	**6**	**280**	**420**	**675**	**21**

COURSE: MTECH II SEMESTER

S. No.	SUBJECT NAME	SUBJECT CODE	L	T	P	Internal Marks	External Marks	Total Marks	Credits
1	Computational Fluid Dynamics	19MTE2TH01	3	-	-	40	60	100	3
2	Design of Thermal Systems	19MTE2TH02	3	-	-	40	60	100	3
	Advanced Refrigeration & Air Conditioning	19MTE2TH03	3	-	-	40	60	100	3
4	Gas Turbines and Jet Propulsion	19MTE2TH04	3	-	-	40	60	100	3
5	**Elective -III**		3	-	-	40	60	100	3
	Energy Conservation Management	19MTE2PE31							
	Solar Energy Technology	19MTE2PE32							
	Renewable Energy Technology	19MTE2PE33							
6	**Elective -IV**		3	-	-	40	60	100	3
	Environmental Pollution and Management	19MTE2PE41							
	Engine Emission Control	19MTE2PE42							
	Alternate fuels and Analysis	19MTE2PE43							
7	Computational methods lab	19MTE2LB01	-	-	6	40	60	100	3
	TOTAL		18	-	6	**280**	**420**	**700**	**21**

S.NO	NAME OF THE SUBJECT	L	P	C
1	Seminar (19MTE3SM)	-	-	1
2	Comprehensive Viva-Voce (19MTE3CV)	-	-	2
3	Project Work (19MTE4PW)	-	-	35
	TOTAL	-	-	38

I M.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE1TH01	**RESEARCH METHODOLOGY AND IPR**						

Course objectives:

- To know the knowledge of framework of research process and various research designs and techniques.
- To understand the various sources of information for literature review and data collection and ethical dimensions of conducting applied research

Course Outcomes:

Students will be able to:

- Develop understanding of the basic framework of research process.
- Develop an understanding of various research designs and techniques.
- Identify various sources of information for literature review and data collection.
- Understand of the ethical dimensions of conducting applied research.

UNIT-1

Research Problem: 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

Measurement and Scaling Concepts: Attitude measurement, levels of measurement and types of scales, criteria for good measurement. Measures of central tendency, measures of dispersion, measures of variation, Correlation and Regression.

UNIT– III

Technical Writing & Research Proposal

Effective literature studies approaches, analysis Plagiarism, Research ethics, 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 Rights A: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. B: International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT– V

Patent Rights: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT– VI

Case Studies: 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.

REFERENCES:

1. PrabhuddhaGanguli: 'Intellectual Property Rights" Tata Mc-Graw–Hill, New Delhi
2. M.Ashok Kumar and Mohd.Iqbal Ali: "Intellectual Property Right" Serials Pub.
3. Carlos M.Correa- ''Intellectual property rights , The WTO and Developing countries"-Zed books
4. Law relating to patents, trademarks, copyright designs, Wadehra, B.L. & 2 ed. Universal Law Publishing 2000.
5. C.R.Kothari, "Research Methodology" New Age International Publishers, Fourth edition, 2018
6. Donald Cooper & Pamela Schindler, "Business Research Methods", TMGH, 9th edition.
7. Alan Bryman& Emma Bell, "Business Research Methods", Oxford University Press.

E Resources:

1. https://www.wto.org/english/tratop_e/trips_e/trips_e.htm
2. https://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm7_e.htm
3. http://nptel.ac.in/courses/110999906/
4. http://nptel.ac.in/courses/109105112/

REFERENCE BOOKS:

1. Optimization theory & Applications, S.S Rao, New Age International
2. Introductory to operation research, Kasan& Kumar, Springer
3. Optimization Techniques theory and practice, M.C Joshi, K.M &Moudgalya, Narosa Publications.
4. Operation Research, H.A. Taha, Tata McGraw-Hill Publications
5. Optimization in operations research, R.L Rardin, Prentice Hall
6. Optimization Techniques, Benugundu&Chandraputla, Pearson Asi

I M.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code:19MTE1TH02	**ADVANCED THERMODYNAMICS**						

Course Objectives:

- To create awareness of the importance of thermodynamic principles in engineering Applications such as I.C engine combustion,
- To understand thermodynamic applications in psychometric, refrigeration and heat Transfer
- To understand the basic principles power cycles and its relation with combustion Processes
- To understand various methods of direct energy conversion

Course Outcomes:

Students will be able to

- Apply various laws of thermodynamics for combustion Phenomena in IC engine
- Select and design air conditioning or psychometric process
- Depending on application and comfort conditions.
- Illustrate the combustion phenomena in IC engines
- Understand various energy conversion methods like fuel cells etc.

UNIT-I

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

UNIT-II

Exergy: Concept of exergy – second law efficiency, exergy change of a system, exergy transfer by heat, work and mass, the decrease of exergy principle and exergy destruction, Exergy balance for open and closed systems.

Irreversibility: Introduction - irreversibility for closed and open system – steady flow process -second law efficiency of steady flow devices.

UNIT-III

P.V.T Surface: Equation of state, Real gas behavior, Vander Waal's equation, Generalization compressibility factor, Energy properties of real gases, Vapor 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-IV

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 gassed, 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-V

Power Cycles: Review binary vapor 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, Thermoelectric circuits.

UNIT-VI

Direct Energy Conversion Introduction: Fuel cells, Thermo electric energy, Thermionic power generation, Thermodynamic devices magneto hydrodynamic generations and Photovoltaic cell

REFERENCE BOOKS:

1. Basic and Applied Thermodynamics, P.K.Nag, Tata McGraw Hill.
2. Thermodynamics, Holman, Tata McGraw Hill.
3. Engineering Thermodynamics, PL.Dhar, Elsevier Publications
4. Thermodynamics for Engineers, Doolittle-Messe, John Wiley & Sons
5. Thermal Engineering, Soman, PHI Publishers
6. Thermal Engineering, Rathore, Tata McGraw Hill.

I M.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE1TH03	**ADVANCED HEAT AND MASS TRANSFER**						

Course Objectives

- To understand the basic principles of mass transfer occurring in process industry and other applications
- To study advanced heat transfer methods of two-dimensional concepts
- To familiarize the basic concepts of various equations and empirical laws pertaining to convection and radiation and also phase transfer phenomena

Course Outcomes

Student will be able to

- apply the laws of various modes of heat transfer depending on application
- solve two dimensional equations in Cartesian coordinates by exact methods
- calculate heat transfer rate associated with phase change heat transfer
- A student will be able to estimate mass diffusion phenomena applied to process industries

UNIT-I

Brief Introduction To Different Modes of Heat Transfer: Conduction: General heat Conduction equation-initial and boundary conditions.

Transient Heat Conduction: Lumped system analysis, Heisler charts-semi-infinite solid-use of shape factors in conduction-2D transient heat conduction-product solutions.

UNIT-II

Finite Difference Methods for Conduction: ID & 2D steady state and simple transient heat conduction problems-implicit and explicit methods.

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.

UNIT-III

External Flows: Flow over a flat plate: integral method for laminar heat transfer coefficient for different velocity and temperature profiles, Application of empirical relations to variation geometries for laminar and turbulent flows.

Internal Flows: Fully developed flow: integral analysis for laminar heat transfer coefficient-types of flow-constant wall temperature and constant heat flux boundary conditions-hydrodynamic &thermal entry lengths; use of empirical correlations.

UNIT-IV

Free Convection: Approximate analysis on laminar free convective heat transfer-Boussinesq 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: Radiant heat exchange in grey, non-grey bodies, with Transmitting, Reflecting and absorbing media, specular surfaces, gas radiation-radiation from flames.

Gas Radiation: Radiation transfer in enclosures containing absorbing and emitting media - interaction of radiation with conduction and Convection.

UNIT-VI

Mass Transfer: Concepts of mass transfer-diffusion & convective mass transfer analogies significance of non-dimensional numbers.

REFERENCE BOOKS:

1. Principals of Heat Transfer, Frank Kreith, Cengage Learning
2. Elements of Heat Transfer, E. Radha Krishna, CRC Press/2012
3. Heat Transfer, RK Rajput, S.Chand
4. Introduction to Heat Transfer, SK Som, PHI
5. Engineering Heat & Mass Transfer, Mahesh Rathore, Lakshmi Publications
6. Engineering Heat & Mass Transfer, Sarit K. Das, DhanpatRai
7. Heat Transfer**,** P.K.Nag**,** TMH

I M. TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE1TH04	**ADVANCED IC ENGINES**						

Course Objectives

- To create awareness of the importance of working principles of I.C. Engines
- To familiarize various techniques to use alternate fuel technology
- To understand different exhaust emissions with the use of alternate fuels.
- To understand the basic concepts of recent trends with change of engine configuration

Course Outcomes

- A student will be able to differentiate the phenomena of combustion in SI and CI engines
- A student will be able to apply alternative fuel technology for gasoline and diesel fuel

UNIT-I

Introduction: Engine Types – Design and operating Parameters.

Spark Ignition Engines: SI Engine mixture requirements, Injection systems Monopoint, Multipoint injection and direct injection.

Compression Ignition Engines: Direct and indirect injection systems – GDI, CRDI, Combustion chambers – Fuel spray behavior – spray structure, spray Penetration and evaporation – air motion.

UNIT-II

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

Recent Trends: Lean Burn Engines – Stratified charge Engines – HCCI engines– Plasma Ignition - Wankel engine, Stirling cycle engine, free piston Engine and Adiabatic engine.

UNIT-IV

Pollutant Formation and Control: Pollutant – Sources – Formation of carbon monoxide, Unburnt hydrocarbon, NOx, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters and Particulate Traps, Methods of measurements and Introduction to emission norms and Driving cycles

UNIT-V

Alternative Fuels: Liquid fuels - Alcohol, Methanol, Ethanol, Gaseous fuels –Hydrogen, Natural Gas and Liquefied Petroleum Gas-properties, production, storage, dispensing, fuel kits, Merits and Demerits, Engine Modifications, use of Bio fuels.

UNIT-VI

Electric Vehicles: Introduction, EV -components, batteries, charges, drives tractive force, transmission, power devices and controllers-Advantages and Disadvantages

Fuel Cell Power Vehicles: Fuel cell vehicle- Efficiency, Types of fuel cellsfuel cell hybrid vehicle-Fuel cell solar vehicle, solar car electrical system, Benefits, fuel regulations.

REFERENCE BOOKS:

1. Internal combustion engines fundamentals, Heywood J.B., McGraw Hill
2. Internal combustion Engines, Mathur& R.P. Sharma, Dhanpat Rai Publications
3. Hybrid and Alternative Fuel Vehicles, James D. Halderman, Prentice Hall 4th ed.
4. Internal Combustion Engines, V. Ganesan, TMH Pub, 2008
5. Alternate fuels, SS Thipse, JAICO Publishers, 2010
6. Alternative Fuel Technology, Erjavec, Arias, Yesdee publications, 2007

I M. TECH I SEMESTER (ELECTIVE-I)	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE1PE05	**GAS DYNAMICS**						

Course objectives:

- To create awareness of the importance of principles of various turbo machines
- To understand the basic fundamentals of compressible flow concepts
- To study non-dimensional numbers in compressible flow and to solve the simple compressible flow problems
- To understand the effect of compressibility in nozzles and diffusers
- To understand the design criteria of nozzles and diffusers
- To solve isentropic compressible flow problems

Course outcomes:

- Apply the fundamental flow equations (conservation of mass and momentum and energy) and basic solution techniques in solving compressible one-dimensional flow.
- Obtain first order solutions for compressible internal flows for variable geometry ducts.
- Obtain first order solutions for compressible internal flows with friction and heat transfer.
- Evaluate basic supersonic flight and associated propulsion systems.

UNIT-I

Fundamental Aspects of Gas Dynamics: Introduction, Isentropic flow in a stream tube, speed of sound, Mach waves; One dimensional Isentropic Flow: Governing equations, stagnation conditions, critical conditions, maximum discharge velocity, isentropic relations.

UNIT-II

Normal Shock Waves: Shock waves, stationary normal shock waves, normal shock wave relations in terms of Mach number

UNIT-III

Oblique Shock Waves: Oblique shock wave relations, reflection of oblique shock waves, interaction of oblique shock waves, conical shock waves; Expansion Waves: Prandtl-Meyer flow, reflection and interaction of expansion waves, flow over bodies involving shock and expansion waves

UNIT-IV

Variable Area Flow: Equations for variable area flow, operating characteristics of nozzles, convergent-divergent supersonic diffusers; Adiabatic Flow in a Duct with Friction: Flow in a constant area duct, friction factor variations, and the Fanno line.

UNIT-V

Flow with Heat Addition or Removal: One-dimensional flow in a constant area duct neglecting viscosity variable flow with heat addition, one-dimensional constant area flow with both heat exchange and friction.

UNIT-VI

Generalized Quasi- One-Dimensional Flow: Governing equation sand influence coefficients, solution procedure for generalized flow with and without sonic point; Two-Dimensional Compressible Flow: Governing equations, vorticity considerations, the velocity potential, linearized solutions, linearized subsonic flow, linearized supersonic flow, method of characteristics.

REFERENCE BOOKS:

1. Gas Dynamics, E. Radhakrishnan, Prentice Hall of India Pvt. Ltd
2. The dynamics and thermodynamics of compressible fluid flow, Ascher H. Shapiro, The Ronald press
3. Elements of Gas Dynamics, HW. Lipmann and A. Roshko, Dover Publications
4. Compressible Fluid Dynamics, Thomson P.A, McGraw-Hill

I M. TECH I SEMESTER (ELECTIVE-I)	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE1PE06	**FUELS AND COMBUSTION**						

Course Objectives:

- To create awareness of the importance of working principles of combustion, and familiarize the knowledge of various types of fuels
- To familiarize various processing methods of solid fuels
- To understand principles of refining liquid fuels, and various types of gaseous fuels and their production
- To familiarize the concept of air fuel ratios for various types of fuel, their importance in combustion and different types of combustion phenomena.

Course Outcomes:

Student will be able to

- Know the processing of solid fuels
- Know various methods of gasification of liquid fuels
- Understand the production of various methods of gaseous fuels
- Estimate air fuel ratio based on the fuel, adiabatic temperatures and understand the kinetics of combustion

UNIT-I

Fuels: detailed classification – Conventional and Unconventional Solid, Liquid, gaseous fuels and nuclear fuels – Origin of Coal – Analysis of coal, Coal – Carburization, Gasification and liquefaction – 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: 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

Thermodynamics of Combustion: Enthalpy of formation – Heating value of fuel - Adiabatic flame, Temperature – Equilibrium composition of gaseous mixtures.

UNIT-IV

Factors influencing flame velocity and thickness flame stabilization - Diffusion flames Combustion Appliances: Gas burners - Functional requirement of burners, Gas burner Classification –Stoker firing –pulverized system of firing.

UNIT-V

Laminar and Turbulent Flames Propagation and Structure: Flame stability – Burning velocity of fuels – Measurement of burning velocity – factors affecting the burning velocity, Combustion of fuel, droplets and sprays – Combustion systems – Pulverized fuel furnaces – fixed Entrained and Fluidized Bed Systems.

UNIT-VI

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

REFERENCE BOOKS:

1. Combustion Fundamentals, Roger A strehlow, McGraw Hill
2. Fuels and combustion, Sharma and Chander Mohan, Tata McGraw Hill
3. Combustion Engineering and Fuel Technology, Shaha A.K., Oxford and IBH
4. Principles of Combustion, Kanneth K.Kuo, Wiley and Sons
5. An Introduction to Combustion, Stephen R. Turns, McGraw Hill
6. Combustion Engineering, Gary L. Berman & Kenneth W. Ragland, McGraw Hill
7. Combustion, Sarkar, McGraw Hill

I M.TECH I SEMESTER (ELECTIVE-I)	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE1PE07	**MEASUREMENTS IN THERMAL ENGINEERING**						

Course Objectives:

To make the student

- Learn the working of various measuring instruments used in the field of thermal engineering
- Learn the measurement of properties like thermal conductivity of solids, liquids and gases
- Learn the measurement of transport properties like diffusion, convective heat transfer
- Introduce to electronic control systems associated with automatically controlling the measuring parameters
- Introduce to applications and important features of various measuring instruments

Course Outcomes:

The student will be able to

- Use appropriate instrument for measurement of specific parameter
- Analyze experimental error, Static and Dynamic characteristics of instruments
- Use appropriate instrument measurement of transport properties
- Practically apply the principles of measurement to engineering applications / projects.

UNIT-I

Instrument classification, static and dynamic characteristics of instruments, experimental error analysis, systematic and random errors, statistical analysis, uncertainty, reliability of instruments, Variable resistance transducers, capacitive transducers, piezoelectric transducers, photoconductive transducers, photovoltaic cells, ionization transducers, Hall effect transducers

UNIT-II

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

UNIT-III

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-IV

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.

UNIT-V

Review of open and closed loop control systems and servo mechanisms, Transfer functions of Mechanical Systems, input and output systems.

UNIT-VI

Measurement Analysis: Chemical, thermal, magnetic and optical gas analyzers, measurement of smoke, dust and moisture, gas chromatography, spectrometry, measurement of pH, Review of basic measurement techniques.

REFERENCE BOOKS:

1. Experimental methods for engineers, Holman, J.P., McGraw-Hill, 1988
2. Intelligent Instrumentation, Barney, Prentice Hall of India, 1988
3. Measurements and Instrumentation in Heat Engineering, Prebrashensky.V.,Vol.1 and 2, MIR Publishers, 1980
4. Instrumentation Devices and systems, Raman,C.S., Sharma, G.R., Mani, V.S.V., Tata McGraw Hill, New Delhi, 1983.
5. Measurements System Application and Design, Doeblin, McGraw Hill, 1978
6. Principles of Measurements and Instrumentation, Morris. A.S, Prentice Hall of India, 1998

I M. TECH I SEMESTER (ELECTIVE-II)	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE1PE08	**FINITE ELEMENT METHOD FOR THERMAL ENGINEERING**						

Course objectives:

- To make student to understand the basics of finite element analysis and its applications in engineering with one dimensional and two dimensional elements.

Course outcomes:

The student will be able to

- Get the knowledge on basics of Finite Element analysis
- Analyze different elements like bar, truss, beam and triangular elements using FEM
- Solve problems related one dimensional heat transfer and fluid flow

UNIT-I

Basic Concepts Of The Finite Element Method: Introduction, working of finite element method, comparison of finite element method with exact, FDM and FVM. Method of weighted residuals, Galerkin's method for 1 -D heat conduction and fluid flow.

UNIT-II

Interpolation Functions For General Element Formulation: Compatibility and completeness requirements, Polynomial forms for 1-D elements, geometric isotropy, triangular elements, rectangular elements, isoparametric formulation, axisymmetric elements, Numerical Integration (1-D and 2-D).

UNIT-III

1-D Steady-State Heat Transfer: FE Formulation using linear and quadratic elements, Numerical problems in composite walls and fins of uniform cross section use linear elements.

1-D Transient Heat Transfer: Derivation of element matrices, solution techniques, Numerical problem with 2 elements.

UNIT-IV

2-D Steady-State Heat Transfer: FE Formulation using linear triangle elements, Problem modeling and boundary conditions.

Axisymmetric Heat Transfer: Finite element formulation using linear triangular elements, Problem modeling and boundary conditions.

UNIT-V

Applications in Fluid Mechanics: Finite Element formulation of 1-D and 2-D Steady, incompressible, inviscid, irrotational fluid flows, Problem modeling and boundary conditions.

UNIT-VI

Mesh Generation & Fem Software: Convergence requirements-mesh generation using tessellation method, Quadtree method and Octree method-Mesh refinement-h, p, x and r refinement band width- preprocessor – solution- post processor-use of software.

REFERENCE BOOKS:

1. Introduction to Finite elements in Engineering, Chandraputla & Belagondu, Universities Press.PHI, Third edition, 2002
2. The finite element method in Heat Transfer, Lewis R.W. et al, Wiley-Blackwell, 1996
3. Finite element method in Heat transfer and fluid dynamics, J.N. Reddy, CRC press, third edition, 2010
4. The Finite Element Method for Fluid Dynamics, Olek C Zienkiewicz, Robert L Taylor,P. Nithiarasu, Elsevier, 7th edition, 2013

I M.TECH I SEMESTER (ELECTIVE-II)	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE1PE09	**HYDROGEN AND FUEL CELL TECHNOLOGIES**						

Course objectives:

- To enlighten on various technological advancements, benefits and prospects of Utilizing hydrogen/fuel cell for meeting the future energy requirements.
- To detail on the hydrogen production methodologies, possible applications and various storage options
- To discuss on the working of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics
- To analyze the cost effectiveness and eco-friendliness of Fuel Cells

Course outcomes:

The student will be able to

- Understand the concepts of hydrogen as alternate fuel for present and future engines
- Illustrate the working of various fuel cells, their relative advantages/ disadvantages and hydrogen generation/storage technologies

UNIT -I

Hydrogen – Basics and Production Techniques

Hydrogen – physical and chemical properties, salient characteristics. Production of hydrogen - steam reforming – water electrolysis – gasification and woody biomass conversion-biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water

UNIT-II

Hydrogen Storage and Applications

Hydrogen storage options – compressed gas – liquid hydrogen – Hydride – chemical Storage-Comparisons, Carbon-Nano tubes– Safety and management of hydrogen

UNIT-III

Applications of Hydrogen

Hydrogen fuel applications–internal combustion engines–turbines and jet engines. Hybrid elective vehicles–ships and submarines

UNIT-IV

Fuel Cells

History – principle - working - thermodynamics and kinetics of fuel cell process - performance evaluation of fuel cell – comparison on battery Vs. fuel cell

UNIT-V

Fuel Cell–Types: Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC-relative merits and demerits

UNIT-VI

Application of Fuel Cell and Economics

Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell, Future trends in fuel cells

REFERENCE BOOKS:

1. Fuel Cells – Principles and Applications, Viswanathan, B and M AuliceScibioh, Universities Press (2006
2. Hydrogen and Fuel Cells: A Comprehensive Guide, Rebecca L. and Busby, Penn Well Corporation, Oklahoma (2005)
3. Hydrogen and Fuel Cells: Emerging Technologies and Applications, Bent Sorensen (Sorensen), Elsevier, UK (2005)
4. Fuel Cell and Their Applications, Kordesch, K and G.Simader, Wiley-Vch, Germany (1996)
5. Fuel Cells: Theory and Application, Hart, A.B and G.J.Womack, Prentice Hall, NewYork Ltd., London (1989)
6. The Hydrogen Economy, Jeremy Rifkin, Penguin Group, USA (2002)

I M.TECH I SEMESTER (ELECTIVE-II)	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE1PE10	**THERMAL & NUCLEAR POWER PLANTS**						

Course objectives:

- To create the awareness of working of thermal and nuclear power plants along with economics
- To understand the importance of steam power plants, their limitations and to familiarize the working principles of boilers, condensers and steam turbines
- To familiarize the working principle of gas turbine plants, stress the need for waste heat recovery and various methods of nuclear power.
- To understand the principles of various flow meters in power plants and stress the need for pollution control

Course outcomes:

The student will be able to

- Analyze the flue gases and understand various methods for waste heat recovery
- Justify the economics for requirement of nuclear power plants
- Measure various parameters involved in power plants and suggest various remedies to control pollution

UNIT-I

Introduction: Sources of energy, Type of Power plants. Direct energy conversion system, Energy sources in India, Recent developments in power generation, Combustion of coal, Volumetric analysis, Gravimetric analysis, Fuel gas analysis.

Steam Power Plant: Introduction. General layout of steam power plant, Modern coal, Fired Steam, Steam power plant, Power plant cycle, Fuel Handling, Combustion equipment, Ash handling, Dust collectors

UNIT-II

Steam Generators: Types, Accessories. Feed water heaters, Performance of boiling, Water treatment, Cooling towers, Steam turbines. Compounding of turbines, Steam condensers, Jet and surface condensers.

UNIT-III

Gas Turbine Power Plant: Open and Closed cycle gas turbine plants, Cogeneration. Combined cycle power plant, Analysis, Waste heat recovery, IGCC power plant, Fluidized bed,Combustion,Advantages,Disadvantages

UNIT-IV

Nuclear Power Plant: Nuclear physics, Nuclear Reactor, Classification, Types of reactors, Site selection, Method of enriching uranium, Application of nuclear power plant. Nuclear Power Plant Safety: Bi-Product of nuclear power generation, Economics of nuclearpower plant, Nuclear power plant in India, Future of nuclear power.

UNIT-V

Economics of Power Generation: Factors affecting the economics, loading factors, Utilization factor, Performance and operating characteristics of power plant, Point economic load sharing, Depreciation, Energy rate, Criteria for optimum loading. Specific economic energy problem

UNIT-VI

Power Plant Instrumentations: Classification, Pressure measuring instrument, Temperature measurement and Flow Measurement, Analysis of combustion gases, Pollution types, Methods of control.

REFERENCE BOOKS:

1. Power Plant Engineering, P.K.Nag, TMH Publications
2. Power Plant Engineering, R.K.Rajput, Lakshmi Publications
3. Power Plant Engineering, P.C.Sharma, Kataria Publications
4. Power Plant Technology, M.M. EI-Wakil, TMH Publications

I M.TECH I SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	0	0	6	40	60	100	3
Code: 19MTE1LB01	**ADVANCED THERMAL ENGINEERING LAB**						

Course Objectives:

To make the student learn the

- Measurement of compressibility factor of real gases
- Estimation of dryness fraction of steam
- Analysis of exhaust gases and flame propagation
- Performance test of variable compression ratio diesel engine , R& AC systems and heat pipe
- Pin fin experiment under forced and natural convection
- Double pipe heat exchanger performance under parallel and counter flow conditions Evacuated tube concentrator

Courses Outcomes:

The student will be able to

- Perform different tests of diesel and petrol engine
- Estimate the dryness fraction of steam
- Conduct performance test on pin fin under forced and natural convection
- Illustrate the importance of heat transfer parameters
- Demonstrate the usage of solar energy for heating purposes

LIST OF EXPERIMENTS: Any TEN Experiments

1. Dryness fraction estimation of steam.
2. Performance test on 4-stroke single cylinder diesel engine
3. Performance test on a variable compression ratio (VCR) petrol engine.
4. Engine exhaust gas analysis with gas analyzer.
5. Determination of COP of refrigeration system.
6. Performance of an air-conditioning system (Demonstration)
7. Pin fin experiment under natural convection heat transfer conditions.
8. Pin fin experiment under forced convection heat transfer conditions.
9. Determination of LMTD of Counter flow and Parallel flow heat exchangers
10. Determination of Stefan Boltzmann Constant
11. Lagged Pipe Apparatus
12. Heat Pipe Apparatus
13. Emissivity measurement
14. Solar Flat Plate Collector

I M.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE2TH01	**COMPUTATIONAL FLUID DYNAMICS**						

Course objectives:

- To understand basic concepts and principles of fluid mechanics
- To develop various types of flows, models and develop algorithms
- To study various methods of grid generation
- To create the awareness of the importance of principles of fluid dynamics in engineering

Course outcomes:

The student will be able to

- Apply the knowledge of CFD, which is useful for engineering applications such as aerodynamic, heat transfer, turbo-machinery etc.
- Illustrate the conjugate heat transfer and use effectively different software packages relevant to CFD.
- A student will be able to understand CFD modeling and to write algorithms techniques for steady flows

UNIT–I

Introduction to Numerical Methods: Finite Difference, Finite Element and Finite Volume Methods, Classification of Partial Differential Equations – Solution of Linear Algebraic Equations – Direct and Iterative Approaches.

UNIT-II

Finite Difference Methods: Taylor's series – FDE formulation for 1D and 2D steady state heat transfer problems – Cartesian, cylindrical and spherical co-ordinate systems – boundary conditions – Un steady state heat conduction – Errors associated with FDE - Explicit Method-Stability criteria – Implicit Method – Crank Nicolson method – 2-D FDE formulation.

UNIT–III

Finite Volume Method: Formation of Basic rules for control volume approach using 1D steady heat conduction equation – Interface Thermal Conductivity - Extension of General Nodal Equation to 2D and 3D Steady heat conduction and unsteady heat conduction

UNIT–IV

FVM to Convection and Diffusion: Concept of Elliptic, Parabolic and Hyperbolic Equations applied to fluid flow – Governing Equations of Flow and Heat transfer – Steady 1D Convection Diffusion – Discretization Schemes and their assessment – Treatment of Boundary Conditions.

UNIT–V

Calculation of Flow Field: Vorticity & Stream Function Method - Staggered Grid as Remedy for representation of Flow Field - Pressure and Velocity Corrections – Pressure Velocity Coupling - SIMPLE & SIMPLER (revised algorithm) Algorithm.

UNIT–VI

Turbulent Flows: Direct Numerical Simulation, Large Eddy Simulation and RANS Models Compressible Flows: Introduction - Pressure, Velocity and Density Coupling.

REFERENCE BOOKS:

1. Computational Fluid Flow and Heat Transfer, Muralidharan & Sundarajan, Narosa Pub.
2. Numerical heat transfer and fluid flow, S.V. Patankar, Hemisphere Pub. House
3. An Introduction to Computational Fluid Dynamics, FVM Method – H.K. Versteeg, W. Malalasekhara PHI Publications
4. Computational Fluid Dynamics, Anderson, TMH Publications
5. Computational Methods for Fluid Dynamics, Ferziger, Peric, Springer
6. Computational Fluid Dynamics, T.J. Chung, Cambridge University
7. Computational Fluid Dynamics, A Practical Approach–Tu, Yeoh, Liu (Elsevier)
8. Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers

I M.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE2TH02	**DESIGN OF THERMAL SYSTEMS**						

Course objectives:

- To create awareness of the importance of Heat exchangers design,
- To understand the basic principles of design and modelling of heat exchangers
- To familiarize principles of design of heat exchangers pertaining to industry
- To understand the basic principles of different types of heat exchangers and cooling towers

Course outcomes:

The student will be able to

- Select heat exchanger as per its application in engineering and do root design heat exchanges
- Understand selection and design of cooling towers
- Design of heat exchangers for advanced applications like process industry

UNIT-I

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 fin and Tabular fin.

UINT-II

Basic Design Methods Of Heat Exchanger: Introduction, Basic equations in design, Overall heat transfer coefficient, LMTD method for heat exchanger analysis, Parallel flow, and Counter flow, Multi pass, cross flow heat exchanger design calculations:

UNIT-III

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 exchanger

UNIT-IV

Condensation of Single Vapours: Calculation of horizontal condenser, Vertical condenser, De-Super heater condenser, Vertical condenser-sub-Cooler, Horizontal Condenser-Sub cooler, Vertical reflux type condenser, Condensation of steam.

UNIT-V

Vaporizers, Evaporators and Reboilers: Vaporizing processes, Forced circulation vaporizing exchanger, Natural circulation vaporizing exchangers, Calculations of a reboiler, 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-VI

Direct Contact Heat Exchanger: Cooling towers, relation between wet bulb & dew point temperatures, The Lewis number and Classification of cooling towers, Cooling tower internals and the roll of fill, Heat Balance. Heat Transfer by simultaneous diffusion and convection, Analysis of cooling tower requirements, Deign of cooling towers, Determination of the number of diffusion units, Calculation of cooling tower performance.

REFERENCE BOOKS:

1. Process Heat Transfer, D.Q.Kern, TMH Publications
2. Cooling Towers, J.D.Gurney and I.A. Cotter, Maclaren Publications
3. Heat Exchanger Design, A.P.Fraas and M.N.Ozisicj, John Wiely& sons

I M.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE2TH03	**ADVANCED REFRIGERATION AND AIR CONDITIONING**						

Course objectives:
To enable the student to
- Understand the principles of refrigeration and air conditioning.
- Calculate the cooling load for different applications.
- Select the suitable equipment for a particular application.
- Design and implement refrigeration and air conditioning systems using standards.

Course Outcomes:
The student will be able to
- Differentiate between various refrigeration systems and apply refrigeration and air conditioning principles
- Design refrigeration systems of conventional and un conventional type
- Illustrate air conditioning systems with considerations of basic components of air conditioning

UNIT –I
Vapour Compression Refrigeration: Performance of Complete vapor compression system.
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: Liquefaction system; 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
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: 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. Summer, winter and year round air – conditioning systems.

UNIT-V

Cooling Load Calculations: Psychometric– Comfort air conditioning -Factors affecting human comfort – Cooling Load calculations.

UNIT–VI

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.

Components: Humidification and dehumidification equipment – Systems of Air cleaning – Grills and diffusers – Fans and blowers – Measurement and control of Temperature and Humidity.

REFERENCE BOOKS:

1. Refrigeration & Air Conditioning, C.P. Arora, TMH Publications
2. Refrigeration & Air Conditioning, Arora&Domkundwar, DhanpatRai Publications
3. Refrigeration and Air Conditioning, Stoecker, McGraw Hill Publications
4. Principles of Refrigeration, Roy. J. Dossat, John Wiley Publications
5. Refrigeration and Air Conditioning, Ananthanarayana, TMH Publications

I M.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE2TH04	**GAS TURBINES AND JET PROPULSION**						

Course objectives:

- To make student to acquire knowledge on power generation through gas turbine.
- To make student to gain knowledge in the application of gas turbine in the field of jet propulsion.
- To make student aware of combustion chambers

Course outcomes:

The student will be able to

- Illustrate the methods of improving thermal efficiency and specific power output of a gas turbine cycle.
- Demonstrate the concepts and working of Ramjet, Pulse Jet, Turbojet and Turboprop etc.
- Draw the velocity vector diagrams of turbine blades and compressor blades.

UNIT-I

Introduction: Cycles for Gas turbine, Performance of Gas turbines, open and closed cycle gas turbine analysis, Components of Turbine, Combustors for gas turbine, fuel requirements.

UNIT-II

Axial Flow Compressors: Principle of operation, Momentum or Filament analysis and energy transfer in rotors, Losses & coefficients of performance, cascade characteristics, overall performance, compressor characteristics, surging, choking and stalling.

UNIT-III

Axial Flow Gas Turbines: Elementary Theory, Turbine and nozzle efficiencies, Degree of reaction, Impulse turbine analysis, Reaction turbine analysis, comparison of Turbine types.

UNIT-IV

Applications of Gas Turbines: Typical applications of gas turbines-electric power generation applications-marine application locomotive applications automotive applications aircraft applications-process applications, additional features of gas turbine engines-trends in future development.

UNIT-V

Jet Propulsion: Introduction, Air breathing Jet engines, classification-Ram jet, pulse jet, Turbo jet, Turbo prop, Thrust, Efficiency-Ram, Thermal, Transmission, overall. Effect of forward speed, altitude, Thrust augmentation - After burning, wateralcohol mixtures, Bleed burn cycle.

UNIT-VI

Rocket Propulsion: Principle, classification-chemical, rocket-solid propellant, liquid propellant, advantages, free radical, Nuclear, Electro dynamic, plasma, photon propulsion.

REFERENCE BOOKS:

1. Gas Turbines, Ganesan V, TMH, 3rd Edition
2. Gas turbines and propulsive systems, Khajuria P.R. Dubey S.P, Dhanpat Rai pub.
3. Gas turbines and jet & rocket propulsion, Mathur M.L, Sharma R.P. Standard Publishers
4. Gas Turbine Theory, Cohen H, Rogers and Saravanamuthu H, John Wiley
5. Turbines, Compressors and Fans, Yahya S.H, Tata McGraw-Hill.
6. Aero-thermodynamics of gas turbine and rocket propulsion, Gordon Oates, AIAA Education series

I M.TECH II SEMESTER (Elective –III)	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE2PE31	**ENERGY CONSERVATION AND MANAGEMENT**						

Course objectives:

- To create awareness of the importance of the energy auditing and determination of evaluation methods of engineering projects
- To understand the principles of energy management for various types of industries
- To understand the need and necessity of energy auditing and estimate the budget for industry
- To understand the importance of renewable energies in the scenario of depletion of conventional energy resources

Course outcomes:

The student will be able to

- Demonstrate the methods of energy management and energy auditing
- Estimate the requirement of any proposed industry by evaluation through project economic analysis
- Summarize different energy utility industries and their functioning

UNIT-I

Introduction: Principles of energy management. Managerial organization, Functional areas for i) manufacturing industry, ii) Process industry, iii) Commerce, iv) Government, Role of Energy manager in each of these organizations. Initiating, Organizing and managing energy management programs

UNIT-II

Energy Audit: Definition and concepts, Types of energy audits, Basic energy concepts, Resources for plant energy studies, Data gathering, Analytical techniques. Energy Conservation: Technologies for energy conservation, Design for conservation of energy materials, Energy flow networks, Critical assessment of energy usage. Formulation of objectives and constrains, Synthesis of alternative options and technical analysis of options, Process integration.

UNIT-III

Economic Analysis: Scope, Characterization of an investment project. Types of depreciation, Time value of money. Budget considerations, Risk analysis.

UNIT-IV

Methods of Evaluation Of Projects: Payback, Annualized costs, Investor's rate of return, Present worth, Internal rate of return, Pros and cons of the common method of analysis, Replacement analysis.

UNIT-V

Alternative Energy Sources: SOLAR ENERGY: Types of devices for solar energy collections, Thermal storage system, Control systems. Wind Energy, Availability, Wind Devices, Wind Characteristics, performance of turbines and systems.

UNIT-VI

Energy Conservation In Electric Utility And Industry: Energy cost and two part tariff, energy conservation in utility by improving load factor, load curve analysis energy efficient motors, Energy conservation in illuminating system, importance of power factor in energy conservation power factor improvement methods, energy conservation in industries.

REFERENCE BOOKS:

1. Energy Management Principles, CB Smith, Pergamon Press
2. Energy Management, W.R.Murthy and G.Mc.Kay, BS Publication
3. Management, H.Koontz and CyrillDonnel, McGraw Hill
4. Financial Management, S.C.Kuchhal, Chaitanya Publishing House

I M.TECH II SEMESTER (Elective –III)	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE2PE32	**SOLAR ENERGY TECHNOLOGY**						

Course objectives:

- To understand the students potential and importance of non-conventional energy sources
- To understand the concept of Solar radiation and Energy conversion
- To understand PV technology principles and techniques of various solar cells/materials for energy conversion.
- To understand Economical and environmental merits of solar energy for variety of applications.

Course Outcomes:

The student will be able to

- Demonstrate the radiation principles with respective solar energy estimation
- Illustrate various collecting techniques of solar energy and storage
- Understand PV technology principles and techniques of various solar cells / materials for energy conversion will be learnt
- Learn Economic and environmental merits of solar energy for variety of applications

UNIT-I

Solar Radiation: Source of radiation – Sun earth relationship- extraterrestrial radiation.– Atmospheric attenuation – Terrestrial radiation-radiation on a horizontal surfaces and inclined planes - relations between monthly, daily and hourly radiation and components of the radiations– solar charts – Critical radiation-Measurement of global, direct and diffuse solar radiation - pyroheliometer, pyranometer, pyrogeometer, sunshine recorder – an overview of solar radiation data in India.

UNIT-II

Solar Flat Plate Collectors: Design considerations – classification- Flat plate collectors- air heating collectors liquid heating –Temperature distributions- Heat removal rate- Useful energy gain - Losses in the collectors-for efficiency of flat plate collectors – selective surfaces.

UNIT-III

Solar Concentric Tube Collectors: Tubular solar energy collectors analysis of concentric tube collector – testing of flat plate collectors. Concentric collectors - Limits to concentration – concentrator mounting – tracking mechanism - performance analysis focusing solar concentrators: Heliostats.

UNIT-IV

Photovoltaic Systems: Conversion of Solar energy into Electricity - Photovoltaic Effect, Photovoltaic material - Solar Cell – Module – Silicon solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature, Efficiency measurements, High efficiency cells, Recent developments in Solar Cells- PV systems - applications

UNIT-V

Energy Storage: Sensible Heat Storage – Liquid media storage – Solid media storage – Latent heat storage - Phase change materials – Chemical storage

UNIT-VI

Industrial Applications of Solar Heat: Solar Thermal Power Plant, Solar Desalination, Solar Water Heating, Solar Air Heating, Solar Drying, Solar Cooking, Solar Greenhouse technology: Fundamentals, design, modeling and applications

REFERENCE BOOKS:

1. Solar Cells and Their Applications, L D. Partain, L M. Fraas, John Wiley and Sons, 2010
2. Solar Energy Engineering, Soteris Kalogirou, Academic Press, 2009
3. Solar Energy, Sukhatme S P, Tata McGraw-Hill Education, 2008
4. Handbook of Photovoltaic Science and Engineering, A Luque, S Hegedus, John Wiley and Sons, 2003
5. Solar Energy Fundamentals, Design, Modeling and Applications, G. N. Tiwari, Narosa Publishing House Pvt. Ltd., 2002
6. Solar Energy- Fundamentals & Applications, H.P. Garg and J. Prakash, Tata McGraw-Hill, 2000

I M.TECH II SEMESTER (Elective –III)	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE2PE33	**RENEWABLE ENERGY TECHNOLOGY**						

Course Objectives:

- To understand the students potential and importance of non-conventional energy sources
- To under the methods of extracting solar energy, wind energy ocean energy and geothermal energy.

Course Outcomes:

The student will be able to

- Work on flat plate collector, concentrating collectors to extract solar energy.
- Understand the power generation through horizontal and vertical axis wind turbines.
- Demonstrate the extraction methods of OTEC, Wave energy and power generation through MHD.

UNIT-I

Introduction: Energy Scenario-Survey of Energy Resources-Classification-Need for Non-Conventional Energy Resources. Solar Energy: The Sun - Sun-Earth Relationship –Solar radiation - Attention - Radiation measuring Instruments.

UNIT-II

Solar Energy Applications: Solar water Heating, Space heating - Active and Passive heating-Energy storage-selective surface - solar stills and ponds-solar refrigeration-photovoltaic generation.

UNIT-III

Wind Energy: Wind- characteristics- wind energy conversion systems- types- Betz model-Interference Factor-Power Coefficient-Torque Coefficient and thrust coefficient- Lift machines and drag machines – matching - electricity generation.

Geothermal Energy: Structure of Earth - Geothermal Regions - Hot springs - Hot Rocks- Hot Aquifers-Analytical Methods to estimate Thermal Potential - Harnessing Techniques - Electricity Generation Systems.

UNIT–IV

Energy from Oceans: Tidal Energy; Tides – Diurnal and Semi – Diurnal Nature – Power from Tides.

Wave Energy: Waves – Theoretical Energy Available – Calculation of period and phase velocity of waves – wave power systems – submerged devices.

Ocean Thermal Energy: Principles – Heat Exchangers – Pumping requirements – Practical Considerations

UNIT-V

Bio–Energy: Biomass Energy Sources – Plant Productivity, Biomass Wastes – Aerobic and Anaerobic bio-conversion processes – Raw Materials and properties of Bio-gas-Bio-gas plant Technology and Status – The Energetic and Economics of Biomass systems – Biomass gasification – Biodiesel

UNIT-VI

Direct Energy Conversion Systems: Fuel Cells and Solar Cells–Thermionic and Thermoelectric Generation – MHD Generator-Open and Closed Systems.

REFERENCE BOOKS:

1. Renewable Energy Resources, JohnTwidell&Tony Weir, Routledge Publishers
2. Non-Conventional Energy Sources, G.D Rai, (4th ed.), Khanna Publishers
3. Renewable Energy Resources, G.N.Tiwari and M.K.Ghosal, Narosa Publication Ltd
4. Renewable Energy Resources, G.N.Tiwari and M.K.Ghosal, Narosa Publication Ltd
5. Non-Conventional Energy, Ashok V Desai, Wiley Eastern

I M.TECH II SEMESTER (Elective –IV)	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code:19MTE2PE41	**ENVIRONMENTAL POLLUTION AND CONTROL**						

Course objectives:

- The course has been designed to improve the understanding of the students about different pollution control strategies and the skills of application of remediation techniques to combat pollution in three environmental compartments i.e. air, water and soil.
- The course will also be dealing about the sources of pollution in air, soil, water, thermal and noise and the impacts these sources on the environment and health.

Course outcomes:

The student will be able to

- Understand of air,water pollution regulations and their scientific basis
- Apply knowledge for the protection and improvement of the environment
- Illustrate marine and nuclear land/soil noise and thermal pollution control systems

UNIT-I

Introduction: Classification of Pollution and Pollutants, Causes, Effects and Sources of Pollution, Primary and Secondary Pollutants, Automobile Pollution, Industrial Pollution.

UNIT-II

Air Pollution: Ambient Air Quality Standards, Air pollution sampling and Measurement-types of pollutant sampling and measurement-Ambient air sampling-collection of gaseous air pollutants- collection of particulate pollutants- stock sampling, analysis of air pollutants-sulfur dioxide- nitrogen dioxide, carbon monoxide, oxidants and ozone hydrocarbons-particulate matter.

UNIT-III

Water Pollution: Point and Non-point Source of Pollution, Major Pollutants of Water, Water Quality Requirement for Different Uses, Global water crisis Issues.

UNIT-IV

Marine And Nuclear Pollution: Misuse of International Water for Dumping of Hazardous Waste, Coastal Pollution Due to Industrial Effluents, Nuclear Power Plants, Nuclear Radiation,DisastersandImpacts,GeneticallyDisorders.

UNIT-V

Land/Soil Pollution: Effects of urbanization on land degradation, Impact of Modern Agriculture on Soil, Effect on Environment and Life sustenance, Abatement measures.

UNIT-VI

Noise and Thermal Pollution: Sources of Noise, Effects of Noise, Industrial Noise-Occupational Health Hazards, Thermal Comforts, Heat Island Effect, Radiation Effects

REFERENCE BOOKS:

1. Introduction to Engineering and Science, Manster, G.M, Pearson Publishers, 2004.
2. Environmental Pollution Control Engineering, Rao, E.S, Wiley Eastern Ltd., 1991
3. Pollution Control in Process Industries, Mahajan, S.P., Tata McGraw-Hill, 1985
4. Air Pollution Control Theory, Crawford, M., TMH, 1976.

I M.TECH II SEMESTER (Elective –IV)	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE2PE42	**ENGINE EMISSION CONTROL**						

COURSE OBJECTIVES:

- Impart knowledge in automotive pollution control systems
- The detailed concept of formation and control techniques of pollutants like UBHC, CO, NOx, particulate matter and smoke for both SI and CI engine.

COURSE OUTCOMES:

Students are able to

- Understand the concepts of pollution formation from engines
- Analyze different parameters of pollution and making correlations
- Estimate the levels of pollution from different sources
- Illustrate different pollution measuring devices and instruments

UNIT I

INTRODUCTION: Pollutants-sources-formation-effects of pollution on environment-human-transient operational effects on pollution-Regulated-Unregulated emissions- Emission Standards.

UNIT II

EMISSIONS IN SI ENGINE: Chemistry of SI engine combustion – HC and CO formation in SI engines – NO formation in SI engines – Smoke emissions from SI engines – Effect of operating variables on emission formation.

UNIT III

EMISSIONS IN CI ENGINE: Basics of diesel combustion – Smoke emission and its types in diesel engines – NOx emission and its types from diesel engines – Particulate emission in diesel engines. Odor, sulfur and Aldehyde emissions from diesel engines – effect of operating variables on emission formation.

UNIT IV

CONTROL TECHNIQUES FOR REDUCTION OF EMISSION: Design modifications-Optimization of operating factors – Fuel modification – Evaporative emission control – Exhaust gas recirculation – SCR – Fumigation – Secondary Air injection – PCV system – Particulate Trap – CCS – Exhaust treatment in SI engines –Thermal reactors – Catalytic converters- Catalysts – Use of unleaded petrol.

UNIT V

TEST PROCEDURE, INSTRUMENTATION & EMISSION MEASUREMENT: Test procedures CVS1, CVS3 – Test cycles – IDC – ECE Test cycle – FTP Test cycle – NDIR analyzer – Flame ionization detectors – Chemiluminescent analyzer – Dilution tunnel – Gas chromatograph – Smoke meters –SHED test.

UNIT-VI

MODELLLING OF POLLUTANT EMISSIONS: Modeling of point sources – air pollution modeling at urban and large scale – Dispersion models – Photochemical modeling- Meteorological models – Particle models – Statistical models

TEXT BOOKS:

1. Springer and Patterson, “Engine Emission”, Plenum Press, 1990.
2. Pundir. B.P., “ IC Engines Combustion and Emissions” Narosa Publishers, 2010

REFERENCES:

1. Ramalingam. K.K., “Internal Combustion Engines”, Scitech Publications, 2003.
2. Ganesan,V., “Internal Combustion Engines”, Tata McGraw Hill Co., 1994.
3. SAE Transactions, “Vehicle Emission”, 3 volumes, 1982. 4. Obert,E.F. “Internal Combustion Engines”, 1982.
4. Taylor,C.F., “Internal Combustion Engines”, MIT Press, 1972.
5. Heywood,J.B., “Internal Combustion Engine Fundamentals”, McGraw Hill Book Co., 1995.
6. Automobiles and Pollution SAE Transaction, 1995.

I M.TECH II SEMESTER (Elective –IV)	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE2PE43	**ALTERNATE FUELS AND ANALYSIS**						

COURSE OBJECTIVES

- To present a problem oriented in depth knowledge of Alternate fuel and energy system.
- To address the underlying concepts and methods behind alternate fuel and energy system.

COURSE OUTCOMES:

Students are able to

- Understand the usage of different alternate fuels for different systems
- Demonstrate the knowledge of extraction of different fuels and storage technologies
- Illustrate the making of different bio fuels from bio sources
- Analyze the fuels with respect to ASTM standardizations

UNIT-I

Need for alternate fuel: Availability and properties of alternate fuels, general use of alcohols, LPG, hydrogen, ammonia, CNG and LNG, vegetable oils and biogas, merits and demerits of various alternate fuels, introduction to alternate energy sources. Like EV, hybrid, fuel cell and solar cars.

UNIT- II

Alcohols: Properties as engine fuel, alcohols and gasoline blends, performance in SI engine, methanol and gasoline blends, combustion characteristics in CI engines, emission characteristics, DME, DEE properties performance analysis, performance in SI & CI Engines.

UNIT- III

Natural Gas, LPG, Hydrogen and Biogas: Availability of CNG, properties, modification required to use in engines, performance and emission characteristics of CNG using LPG in SI & CI engines, performance and emission of LPG. Hydrogen; storage and handling, performance and safety aspects.

UNIT-IV

Technical Background of Diesel/Bio-diesel fuels-Oil feed stocks: Transesterification-Bio-diesel production from Vegetable oils and waste cooking oil-High blend levels of bio-diesel-Testing, Bio-diesel-Oxidation stability-Performance in Engines, Properties of bio-fuels and their importance in the context of IC Engines.

UNIT-V

Electric, Hybrid, Fuel Cell and Solar Cars: Layout of an electric vehicle, advantage and limitations, specifications, system components, electronic control system, high energy and power density batteries, hybrid vehicle, fuel cell vehicles, solar powered vehicles.

UNIT-VI

Analysis of Fuels: Determination of Gross Calorific Value and calculation of net calorific value, Determination of Moisture content, biomass content of primary and alternate fuels, volatile matter in a fuel. Total carbon, hydrogen and nitrogen in fuels. Review of ASTM methods of fuel analysis.

Reference Books:

1. Alternate Fuels – Dr. S. S. Thipse – Jaico Publications
2. Richard. L. Bechfold, Alternative Fuels Guide BooK, SAE International Warrendale – 1997.
3. MaheswarDayal, Energy Today & tomorrow, -1 & B Horishr India-1982.
4. Nagpal, Power Plant Engineering, Khanna Publishers, 1991.
5. Alcohols as motor fuels progress in technology, Series No. 19 – SAE Publication USE – 1980.
6. SAE paper nos. 840367, 841333, 841334, 841156, Transactions, SAE, USA
7. Alternative Fuels Guidebook – Bechtold R

I M.TECH II SEMESTER	L	T	P	INTERNAL MARKS	EXTERNAL MARKS	TOTAL MARKS	CREDITS
	3	0	0	40	60	100	3
Code: 19MTE2LB01	**COMPUTATIONAL METHODS LABORATARY**						

Course Objectives:

To make the student understand

- Solution of problems of heat conduction using fem software
- Solving problems involving heat transfer from fins by writing program codes in MAT Lab software
- Solving problems containing flow and heat transfer using FVM software

Course Outcomes:

The student will be able to

- Write program to heat transfer problems and solve them using MAT Lab
- Solve some heat transfer problems using FEM/FVM software

LIST OF NUMERICAL PROBLEMS Any TEN numerical problems

The following problems can be solved using MATLAB or Ansys.

1. One dimensional steady state heat conduction in a slab.
2. Two dimensional unsteady state heat conduction in a slab.
3. Heat transfer through a rectangular fin.
4. Heat transfer through a triangular fin.
5. Laminar flow through a rectangular duct.
6. Laminar natural convection on a vertical plate.
7. Simulation of flow in a Parallel flow double pipe heat exchanger.
8. Simulation of flow in a Counter flow heat exchanger.
9. Solution of a second order ordinary differential equation by fourth-order Runge-Kutta Method.
10. Solution of simultaneous first order ordinary differential equations by fourth-order Runge- Kutta Method.

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