ACADEMIC REGULATIONS
AND
SYLLABUS

M.Tech.
in
THERMAL ENGINEERING
w.e.f.
2015-2016 (VR 15)

DEPARTMENT OF MECHANICAL ENGINEERING

VELAGAPUDI RAMAKRISHNA

SIDDHARTHA ENGINEERING COLLEGE

(An Autonomous Institution affiliated to Jawaharlal Nehru Technological University Kakinada, Kakinada,
NBA Accredited & ISO 9001:2008 Certified)
(Sponsored by Siddhartha Academy of General and Technical Education)
Kanuru, Vijayawada-520 007, A.P, India

VELAGAPUDI RAMAKRISHNA SIDDHARTHA ENGINEERING COLLEGE
(Autonomous)
Kanuru, Vijayawada – 520 007

(Approved by AICTE, Accredited by NAAC with 'A' Grade, and ISO 9001: 2008 Certified) (Affiliated to Jawaharlal Nehru Technological University, Kakinada)

Academic Regulations for M.Tech(VR15) w.e.f: 2015-2016 (Common to all branches)

1. INTRODUCTION

Academic Programmes of the College are governed by rules and regulations as approved by the Academic Council, which is the highest Academic Body of the Institute. These academic rules and regulations are effective from the academic year 2015-16, for students admitted into two year PG programme offered by the college leading to Master of Technology (M. Tech).

The regulations listed under this head are common for postgraduate programmes, leading to award of M. Tech degree, offered by the college with effect from the academic year 2015-16 and they are called as "M. TECH-15" regulations.

The regulations here under are subjected to amendments as may be made by the Academic Council of the college from time to time, keeping the recommendations of the Board of Studies in view. Any or all such amendments will be effective from such date and to such batches of candidates including those already undergoing the programme, as may be decided by the Academic Council.

2. DEFINITIONS

a) "Commission" means University Grants Commission (UGC)

b) "Council" means All India Council for Technical Education (AICTE)

c) "University" means Jawaharlal Nehru Technological University Kakinada, Kakinada (JNTUK)

d) "College" means Velagapudi Ramakrishna Siddhartha Engineering College (VRSEC)

e) "Programme" means any combination of courses and/or requirements leading to the award of a degree

f) "Course" means a subject either theory or practical identified by its course title and code number and which is normally studied in a semester.

g) "Degree" means an academic degree conferred by the university upon those who complete the postgraduate curriculum.

3. PROGRAMMES OFFERED

The nomenclature and its abbreviation given below shall continue to be

used for the degree programmes under the University, as required by the Council and Commission.

Master of Technology (M. Tech) Besides, the name of the programme shall be indicated in brackets after the abbreviation. For example PG engineering degree in Computer Science and Engineering is abbreviated as M. Tech (Computer Science and Engineering).

Presently, the college is offering Post Graduate programme in Engineering with the following programmes:

Table 1: List of Programmes offered by college leading to M.Tech Degree

S.No	Programme	Department
1	Structural Engineering	Civil Engineering
2	Computer Science and Engineering	Computer Science and Engineering
3	Power Systems Engineering.	Electrical and Electronics Engineering
4	Communication Engineering and Signal Processing	Electronics and Communication Engineering
5	Telematics	
6	VLSI Design and Embedded Systems	
7	Computer Science & Technology	Information Technology
8	CADCAM	Mechanical Engineering
9	Thermal Engineering	

These Regulations shall be applicable to any new postgraduate programme (M. Tech) that may be introduced from time to time.

4. DURATION OF THE PROGRAMME

- The duration of the programme is two academic years consisting of four semesters.
- A student is permitted to complete the programme within a maximum duration of 4 years.

5. MINIMUM INSTRUCTION DAYS

- Each semester shall consist of a minimum of 90 instruction days with about 25 to 35 contact periods per week.

6. ELIGIBILITY CRITERIA FOR ADMISSION

- The eligibility criteria for admission into M.Tech programme are as per the guidelines of Andhra Pradesh State Council of Higher Education (APSCHE).

6.1 CATEGORY –A Seats:

- These seats will be filled by the Convener, PGECET Admissions.

6.2 CATEGORY –B Seats :

- These seats will be filled by the College as per the guidelines of Andhra Pradesh State Council of Higher Education (APSCHE).

7. PROGRAMME STRUCTURE

The programme structure is designed in such a way that it facilitates the courses required to attain the expected knowledge, skills and attitude by the time of their post-graduation as per the needs of the stakeholders. The curriculum structure consists of various course categories to cover the depth and breadth required for the programme and for the attainment of programme outcomes of the corresponding programme.

7.1 Programme Core:

The core consists of set of courses considered necessary for the students of the specific. The courses under this category should satisfy the programme specific criteria prescribed by the appropriate professional societies. The credits for programme core courses is 40.

7.2 Programme Electives:

The Electives are set of courses offered in the which covers depth and breadth to further strengthen their knowledge. The students may register for appropriate electives offered in the based on their area of interest. The credits for the programme electives are 12.

7.3 Independent Learning:

The students are expected to learn the courses offered under this category on their own. The courses offered under this category include:

7.3.1 Self-Learning Course:

The self-learning courses shall be taken from the list of approved MOOCs in the respective Board of Studies. The courses under this category shall carry two credits.

7.3.2 Seminar:

One seminar shall be delivered by the students as individual presentation. The seminar topics shall be related to the contemporary aspects of the programme. The seminar shall carry 2 credits.

- The self learning course and seminar shall be offered either in 1st year or in 2nd year of the programme depending upon this scheme approved by BOS & Academic Council.

7.3.3 Project:

The Project shall be offered in 2nd year of the programme. The project shall be carried out by the students, as individual project, for a minimum period of one academic year. The project shall be carried out in the major areas pertaining to the programme approved by Project Review Committee and may address the societal problems/issues related to the programme. The project shall consist of Part-A and Part-B with a weightage of 10 and 14 credits, respectively spreading over for one semester each. The project part B shall be the extension of project Part A.

- If a candidate wishes to change his/her topic of the project, he/she can do so with approval of the project review committee within one week from the completion of 1st review.

7.3.3.1 PROJECT IN COLLABORATION WITH INDUSTRY:

- A student may, with the approval of the Head of the Department/ Centre, visit an industry or a Research Laboratory for data collection, discussion of the project, experimental work, survey, field studies, etc. during the project period. Projects sponsored by the industry or Research Laboratories will be encouraged and a close liaison with such organizations will be maintained.
- A student may, with the approval of Project Review Committee, do the project work in collaboration with an industry, a Research and

Development Organization. A Joint Supervisor may be appointed from the Industry and Research Laboratory with the approval of the HOD. The student shall acknowledge the involvement and / or contribution of an industry, R&D organization in completing the project in his/her thesis and a certificate to this effect, issued by the supervisor from the industrial organization, will be included in the thesis. The Internal Supervisor may visit the industry or the research laboratory in connection with the project work of his / her student if felt necessary.

- It is mandatory for all the students (especially those who do their project in an Industry, R&D organization in India or abroad) to make full disclosure of all data on which they wish to base their project. They cannot claim confidentiality simply because it would come into conflict with the Industry's or R&D laboratory's own interests. Any tangible intellectual property other than copyright of the thesis may have to be assigned to the Institute. The copyright of the thesis itself would however lie with the student as per the IPR policy in force.

7.4 Course Code and Course Numbering Scheme

Course Code consists of Nine characters in which the one is the numeral and second to fourth are alphabets and the rest are numerals.

- The First character '15' indicates year of regulation.
- The second to fourth characters are described in Table 2 and 3.

Table 2: Second to Third Character description

Second & Third Characters	Name of the Department
CE	Civil Engineering Department
CS	Computer Science and Engineering Department
EC	Electronics & Communication Engineering Department
EE	Electrical & Electronics Engineering Department
IT	Information Technology Department
ME	Mechanical Engineering Department

The fourth and fifth characters represents specialization offering as mentioned in Table No. 3.

Table 3: Fourth and Fifth Character description

Fourth & Fifth Characters	Name of the Specialization
SE	Structural Engineering
CS	Computer Science and Engineering
SP	Communication Engineering and Signal Processing
VE	VLSI Design and Embedded Systems
TM	Telematics
PS	Power Systems Engineering
CT	Computer Science & Technology
CC	CADCAM
TE	Thermal Engineering

For all the Sixth and Seventh characters represent semester number and syllabus version number of the course offered.

Eighth character represents course type, as per Table No. 4

Table 4: Course type description

EIGHTH CHARACTER	DESCRIPTION
0	Theory course
5	Lab course

Nineth character represents course number as described in Figure 1 below.

For example, in **15 MECC 1051** course, the numeral **15** indicates year of regulation and the course is offered by Mechanical Engineering Department (**ME**) in CAD/CAM specialization offered in the first semester (**1**), the course syllabus version number (**0**), the course is of lab type (**5**) and the course number is (**1**), as given in figure.1 below.

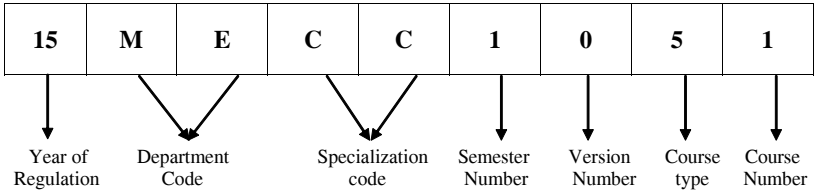

Figure 1: Course Code Description

7.5 Scheme of Instruction for 1st and 2nd Years

The scheme of instruction and exact syllabi of all post graduate programmes are given separately.

7.6 Contact Hours and Credits

Credit means quantifying and recognizing learning. Credit is measured in terms of contact hours per week in a semester.

The Course Credits are broadly fixed based on the following norms:

- Lectures – One Lecture period per week is assigned one credit.
- Tutorials - Two tutorial periods per week are assigned one credit.
- Practical – 2 periods per week is assigned one credit
- Seminar/Mini Project shall have 2 credits.
- Major Project shall have 24 credits.

- However, some courses are prescribed with fixed number of credits depending on the subject complexity and importance.

7.7 Theory / Tutorial Classes

Each course is prescribed with fixed number of lecture periods per week. During lecture periods, the course instructor shall deal with the concepts of the course. For certain courses, tutorial periods are prescribed, to give exercises to the students and to closely monitor their learning ability.

7.8 Laboratory Courses

A minimum prescribed number of experiments have to be performed by the students, who shall complete these in all respects and get each experiment evaluated by teacher concerned and certified by the Head of the Department concerned at the end of the semester.

7.9 Programme Credits

Each specialization of M. Tech programme is designed to have a total of 80 credits, and the student shall have to earn all the credits for the award of degree.

8. MEDIUM OF INSTRUCTION

The medium of instruction and examination is English.

9. SYLLABUS

As approved by the concerned BOS and the Academic Council.

10. ELIGIBILITY REQUIREMENT FOR APPEARING SEMESTER END EXAMINATION AND CONDONATION

- A regular course of study means a minimum average attendance of 75% in all the courses computed by totaling the number of periods of lectures, tutorials, practical courses and project as the case may be, held in every course as the denominator and the total number of periods attended by the student in all the courses put together as the numerator.
- Condonation of shortage in attendance may be recommended by the respective Heads of Departments on genuine medical grounds, provided the student puts in at least 65% attendance as calculated

above and provided the Principal is satisfied with the genuineness of the reasons and the conduct of the student.

- Students, having shortage of attendance, shall have to pay the requisite fee towards condonation**.**
- Minimum of 50% aggregate marks must be secured by the candidates in the continuous evaluations conducted in that semester for courses such as theory, laboratory courses, seminar and project to be eligible to write semester end examinations. However, if the student is eligible for promotion based on the attendance, in case necessary, a shortage of internal marks up to a maximum of 10% may be condoned by the Principal based on the recommendations of the Heads of the Departments.
- Students having shortage of internal marks up to a maximum of 10% shall have to pay requisite fee towards condonation**.**
- A student, who does not satisfy the attendance and/or internal marks requirement, shall have to repeat that semester.
- Eligible candidates who failed to register for all courses for the semester-end examinations shall not be permitted to continue the subsequent semester and has to repeat the semester for which he/she has not registered for semester end examinations.

11. EXAMINATIONS AND SCHEME OF EVALUATION

11.1 Continuous Evaluation:

11.1.1 Theory Courses

Each course is evaluated for **40** marks (a+b)

a) The continuous evaluation shall be made based on the two midterm examinations each of 2**0** marks will be conducted in every theory course in a semester. The mid term marks shall be awarded giving a weightage of 2/3rd in the examination in which the student scores more marks and 1/3rd for the examination in which the student scores less marks. Each midterm examination shall be conducted for duration of 90 minutes without any choice**.**

b) The remaining 20 marks are awarded through continuous evaluation of assignments / mini project in each subject as notified by the teacher at the beginning of the semester.

Students shall be informed regarding the comprehensive assignment/ during the first week of the semester and they have to submit completed assignment on or before 12th week of semester.

11.1.2 Laboratory Courses: 40 marks

- For Laboratory courses there shall be continuous evaluation during the semester for 40 continuous evaluation marks. The distribution of continues evaluation marks is given below:

Table 5: Distribution of Marks

Sl. No.	Criteria	Marks
1	Day to Day work	10
2	Record	10
3	Continuous Evaluation	20

11.1.3 Seminar: 40 marks

The distribution of continues evaluation marks for the seminar is given below.

Table 6: Distribution of Marks

Sl. No.	Criteria	Marks
1	Report	15
2	Presentation	15
3	Viva-voce	10

The Seminar Review Committee (SRC) to be constituted by HOD with minimum two members related to programs specialization.

11.1.4 Project: (40 marks)

The continuous evaluation (Project Part A and Project Part B) for 40 marks shall be on the basis of two seminars by each student evaluated by a review committee and the day to day assessment by the supervisor in respective semester. The review committee consists of HOD, Programme coordinator,

respective internal guide and two senior members of faculty of the department with expertise in the respective specialization nominated by HOD. The distribution of marks is as follows in Table 7.

Table 7: Continuous evaluation in each semester

Sl. No.	Criteria	Marks
1	Two reviews	15+15
2	Day to day assessment	10

Rubrics shall be prepared by review committee using appropriate performance indicators for each review separately and informed to the students well in advance.

11.1.5 Self-Learning Courses

For the courses under this category, there shall be continuous evaluation for 40 marks and semester end examination of 60 marks. The distribution of marks for continuous evaluation will be same as theory courses (Section 11.1.1).

11.2 SEMESTER END EXAMINATIONS

11.2.1 Theory Courses: 60 marks

The Semester end examinations shall be conducted for 3 hours duration at the end of the semester. The question paper shall be given in the following pattern: There shall be two questions from each unit with internal choice. Each question carries 15 marks. Each course shall consist of four units of the syllabus.

11.2.2 Lab Courses: 60 marks

40 marks are allotted for experiments/job works & **15** marks are allotted for viva-voce examination and **5** marks for the record.

11.2.3 Seminar: 60 marks

There shall be a seminar presentation. For Seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the Department in a report form and shall make an oral presentation before the Departmental Committee. The

Departmental Committee consists of Head of the Department, supervisor and two other senior faculty members of the department. For Seminar, the evaluation is done for 60 marks internally.

11.2.4 Self-Learning Courses: 60 marks

The semester end examinations for courses under this category are evaluated for 60 marks.

11.2.5 Project: 60 marks

The project (Project Part A and Part B) shall be evaluated for 60 marks in respective semesters. The semester end examination for project part – A shall be evaluated by HOD, Programme coordinator and one of the senior Professors of the Department.

Project part – B shall be evaluated by a project evaluation committee consisting of the Head of the Department, project internal guide and an external examiner approved by the Principal from a panel submitted by the HOD.

The rubrics for evaluation of semester end examination shall be defined by the Project review committee separately for Part – A and Part B.

12. CONDITIONS FOR PASS AND AWARD OF CREDITS FOR A COURSE

12.1 Conditions for Pass and award of Grades & Credits:

a) A candidate shall be declared to have passed in individual Theory course if he/she secures a minimum of 50% aggregate marks (continues evaluation & semester end examination marks put together), subject to a minimum of 40% marks in the semester end examination.

b) A candidate shall be declared to have passed in individual labs/ seminar/ course if he/she secures a minimum of 50% aggregate marks (continues evaluation & semester end examination marks put together), subject to a minimum of 50% marks in the semester end examination.

c) If a candidate secures minimum of 40% marks in Theory Courses in the semester end examination and 40% - 49% of

the total marks in the semester end examination and continues evaluation taken together in some theory courses and secures an overall aggregate of 50% in all theory courses in that semester he/she declared to be passed in the theory courses of that semester in semester end Examinations. This provision is applicable for Regular candidates only during Regular Semester – end Examinations.

d) The student has to pass the failed course by appearing the examination when conducted subsequently, as per the requirement for the award of degree.

e) A candidate shall be declared to have passed the Project part A/ Project part B, if he/she secures minimum of 50 % aggregate marks (continuous evaluation and semester end examination marks put together), subject to a minimum of 50 % of marks in semester end examinations.

f) If any candidate does not fulfill the pass requirement as per 12.1.(e) in semester end examination of Project Part – A, he / she will be given two months additional time to re appear at the semester end examination after paying the requisite examination fee and also the candidate has to bear the expenditure for conducting examination. If the candidate does not fulfill the pass requirement again in Project Part – A as per 12.1(e), he/she has to repeat the semester in next academic year.

g) In a special case, if any student does not submit his / her thesis of Project Part – B, due to ill health or any other genuine reason, he / she will be given another chance to appear at Project Part - B examination conducted separately at a later date i.e. within two months from the completion of Project Part – B semester end examination of that particular academic year after paying the requisite examination fee, if the expenditure for conducting Project Part – B is completely borne by the candidate.

h) On passing a course of a programme, the student shall earn assigned credits in that Course.

12.2 Method of Awarding Letter Grades and Grade Points for a Course.

A letter grade and grade points will be awarded to a student in each course based on his/her performance as per the grading system given below.

Table 8: Grading System for individual subjects/labs

Theory	Lab	Grade Points	Letter Grade
>= 90%	>= 90%	10	Ex
80-89%	80-89%	9	A+
70-79%	70-79%	8	A
60-69%	60-69%	7	B
50-59%	55-59%	6	C
45-49%	50-54%	5	D
40-44%	-	4	E
< 40%	< 50%	0	F (Fail)
ABSENT	ABSENT	0	AB

12.3 Calculation of Semester Grade Points Average (SGPA)* and award of division for the program.

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

$$SGPA = \frac{\sum (CR \times GP)}{\sum CR} \quad \text{(For all courses passed in semester)}$$

Where CR= Credits of a course

GP = Grade points awarded for a course

*SGPA is calculated for the candidates who passed all the courses in that semester.

12.4 Calculation of Cumulative Grade Point Average (CGPA) for Entire Programme.

The CGPA is calculated as below:

$$CGPA = \frac{\sum (CR \times GP)}{\sum CR} \qquad \text{(For entire programme)}$$

Where CR= Credits of a course

GP = Grade points awarded for a course

Table 9: Award of Divisions

CGPA	DIVISION
≥7.75	First Class with distinction
≥6.5 - <7.75	First Class
≥5.5 - <6.5	Second Class
≥4 - <5.5	Pass Class
<4	Fail

For the purpose of awarding first class with distinction, the candidate should complete the programme with in 2 years and should get required CGPA.

Detained, Break in study candidates, and the candidates who availed themselves of the opportunity of extension of project part – B for a further period of two months are not eligible for the award of first class with distinction.

For the purpose of awarding first/ second/ pass class, CGPA obtained in the examinations appeared within the maximum period allowed for the completion of course including extensions in project, if any shall be considered.

12.5 Transitory Regulations

A candidate, who is detained or discontinued in the semester, on readmission shall be required to pass all the courses in the curriculum prescribed for such batch of students in which the student joins subsequently and the academic regulations be applicable to him/her

which have in force at the time of his/her admission. However, exemption will be given to those candidates who have already passed in such courses in the earlier semester(s) and additional subjects are to be studied as approved by Board of Studies and ratified by Academic Council.

12.6 Consolidated Grade Card

A consolidated grade card containing credits & grades obtained by the candidates will be issued after completion of the two years M. Tech Programme.

13. READMISSION CRITERIA

A candidate, who is detained in a semester due to lack of attendance/marks, has to obtain written permission from the Principal for readmission into the same semester after duly fulfilling all the required norms stipulated by the college in addition to paying an administrative fee of Rs. 1,000/-.

Rules for Calculation of Attendance for Re- Admitted students.

a) No.of classes conducted will be counted from the day 1 of the semester concerned, irrespective of the date of payment of tuition fee.

b) They should submit a written request to the principal of the college, along with a challan paid towards tuition and other fee. for re-admission before the commencement of class work.

c) Student should come to know about the date of commencement of class – work of the semester in to which he / she wishes to get re – admission. The information regarding date of commencement of class – work for each semester is available in the college notice boards / website.

14. BREAK IN STUDY

Student, who discontinues the studies for whatsoever may be the reason, can get readmission into an appropriate semester of M. Tech program after a break-in study only with the prior permission of the Principal of the College provided such candidate shall follow the transitory regulations applicable to such batch in which he/she joins. An administrative fee of Rs. 2000/- per each year of break in study in

addition to the prescribed tuition and special fee has to be paid by the candidate to condone his/her break in study.

15. ELIGIBILITY FOR AWARD OF M.TECH. DEGREE

The M. Tech., Degree shall be conferred on a candidate who satisfies the following requirement. A student should register himself for 80 Credits, and should obtain all the 80 credits in order to become eligible for the award of M.Tech Degree.

16. CONDUCT AND DISCIPLINE

- Students shall conduct themselves within and outside the premises of the Institute in a manner befitting the students of our Institute.
- As per the order of the Honorable Supreme Court of India, ragging in any form is considered a criminal offense and is banned. Any form of ragging will be severely dealt with.
- The following acts of omission and/or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures with regard to ragging.

  i. Lack of courtesy and decorum; indecent behavior anywhere within or outside the campus.

  ii. Willful damage or distribution of alcoholic drinks or any kind of narcotics to fellow students /citizens.

The following activities are not allowed within the campus

- Possession, consumption or distribution of alcoholic drinks or any kind of narcotics or hallucinogenic drugs.
- Mutilation or unauthorized possession of library books.
- Noisy and unseemly behavior, disturbing studies of fellow students.
- Hacking computer systems (such as entering into other person's areas without prior permission, manipulation and/or damage of computer hardware and software or any other cyber crime etc.
- Use of cell phones in the campus.

- Plagiarism of any nature.
- Any other act of gross indiscipline as decided by the college from time to time.
- Commensurate with the gravity of an offense, the punishment may be reprimanded, fine, expulsion from the institute / hostel, debarment from a examination, disallowing the use of certain facilities of the Institute, rustication for a specified period or even outright expulsion from the Institute, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.
- For an offense committed in (i) a hostel (ii) a department or in a classroom and (iii) elsewhere, the Chief Warden, the Head of the Department and the Principal, respectively, shall have the authority to reprimand or impose fine.
- Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the Principal for taking appropriate action.
- Unauthorized collection of money in any form is strictly prohibited.
- Detained and Break-in-Study candidates are allowed into the campus for academic purposes only with permission from the authorities.
- Misconduct committed by a student outside the college campus, but having the effect of damaging, undermining & tarnishing the image & reputation of the institution will make the student concerned liable for disciplinary action commensurate with the nature & gravity of such misconduct.
- The Disciplinary Action Committee constituted by the Principal, shall be the authority to investigate the details of the offense, and recommend disciplinary action based on the nature and extent of the offense committed.
- “Grievance appeal Committee” (General) constituted by the Principal shall deal with all grievances pertaining to the academic / administrative /disciplinary matters.

◆ All the students must abide by the code and conduct rules of the college.

17. MALPRACTICES

◆ The Principal shall refer the cases of malpractices in internal assessment tests and Semester-End Examinations, to a Malpractice Enquiry Committee, constituted by him/her for the purpose. Such committee shall follow the approved scales of punishment. The Principal shall take necessary action, against the erring students based on the recommendations of the committee.

◆ Any action on the part of the candidate at an examination 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. The involvement of the Staff, who are in charge of conducting examinations, valuing examination papers and preparing/keeping records of documents relating to the examinations in such acts (inclusive of providing incorrect or misleading information) that infringe upon the course of natural justice to one and all concerned at the examination shall be viewed seriously and recommended for award of appropriate punishment after thorough enquiry.

18. OTHER MATTERS

18.1 The physically challenged candidates who have availed additional examination time and a scribe during their B. Tech/PGECET/GATE examinations will be given similar concessions on production of relevant proof/documents.

18.2 Students who are suffering from contagious diseases are not allowed to appear either internal or semester end examinations.

18.3 The students who participated in coaching/tournaments held at the state / National /International levels through University / Indian Olympic Association during the end semester external examination period will be promoted to subsequent semesters till the entire course is completed as per the guidelines of University Grants Commission Letter No. F.1-5/88 (SPE/PES), dated 18-08-1994.

18.4 The Principal shall deal with any academic problem, which is not covered under these rules and regulations, in consultation with the Heads of the Departments in an appropriate manner, and subsequently

such actions shall be placed before the academic council for ratification. Any emergency modification of regulation, approved in the Heads of the Departments Meetings, shall be reported to the academic council for ratification.

19. AMENDMENTS TO REGULATIONS

The Academic Council may, from time to time, revise, amend, or change the regulations, Schemes of examination and/or syllabi.

DEPARTMENT OF MECHANICAL ENGINEERING :: VRSEC
M. Tech Thermal Engineering
Scheme of Instruction and Evaluation

FIRST SEMESTER:

Name of the Subjects	Hrs / Week			Credits	Evaluation (marks)			
					Internal	External		Total
	L	T	P			Theory	Practical	
1. 15METE1001 Advanced Thermodynamics	4	-	-	4	40	60	-	100
2. 15METE1002 Advanced Heat Transfer	4	-	-	4	40	60	-	100
3. 15METE1003 Advanced Fluid Mechanics	4	1	-	5	40	60	-	100
4. 15METE1004 Finite Element Analysis for Thermal Engineering	4	-	-	4	40	60	-	100
5. 15METE1005 Elective – I	3	1	-	3	40	60	-	100
6. 15METE1006 Elective – II	3	1	-	3	40	60	-	100
7. 15METE1051 Advanced Thermal Engineering Lab	-	-	3	2	40	-	60	100
8. 15METE1052 Thermal FEM Lab	-	-	3	2	40	-	60	100
Total	22	3	6	27	320	360	120	800

ELECTIVE I

15METE1005A: Measurements in Thermal Engg.
15METE1005B: Fuels, Combustion and Emission Control
15METE1005C: Nuclear Power Plants

ELECTIVE II

15METE1006A: Advances in I.C. Engines
15METE1006B: Solar Energy Utilization
15METE1006C: Thermal Storage Technologies

SECOND SEMESTER:

Name of the Subjects	Hrs/Week			Credits	Evaluation (marks)			
	L	T	P		Internal	External		Total
						Theory	Practical	
1. 15METE2001 Gas Turbinesand Jet Propulsion	4	-	-	4	40	60	-	100
2. 15METE2002 Design of Heat Transfer Equipment	4	-	-	4	40	60	-	100
3. 15METE2003 Advanced Refrigeration and Air Conditioning	4	-	-	4	40	60	-	100
4. 15METE2004 Computational Fluid Dynamics	4	1	-	5	40	60	-	100
5. 15METE2005 Elective-III	3	1	-	3	40	60	-	100
6. 15METE2006 Elective-IV	3	1	-	3	40	60	-	100
7. 15METE2007 (Self Learning) Engine Emission Control	-	-	-	2	40	60	-	100
8. 15METE2051 Fluid Dynamics Lab	-	-	3	2	40	-	60	100
9. 15METE2052 Miniproject & Seminar	-	-	3	2	40	-	60	100
Total	22	3	6	29	360	420	120	900

ELECTIVE III

15METE2005A: Renewable Energy Systems
15METE2005B: Hydrogen and Fuel Cell Technologies
15METE2005C: Cryogenics

ELECTIVE IV

15METE2006A: Energy Conservation & Management
15METE2006B: Environmental Engg. & Pollution Control
15METE2006C: Gas Dynamics

THIRD SEMESTER & FOURTH SEMESTER:

Code	Course	Credits	Internal	External	Total
15METE3051	**Major Project Part-A**	**10**	**40**	**60**	**100**
15METE4051	**Major Project Part-B**	**14**	**40**	**60**	**100**

PROGRAMME OUTCOMES (PO's)

a) Able to apply higher order thinking for enhancement of new knowledge by acquiring in depth knowledge in Thermal Science and Engineering. **[Scholarship of knowledge]**

b) Able to analyze complex engineering problems critically and synthesize independently for creative advances. **[Critical Thinking]**

c) Able to think laterally to solve engineering problems for arriving at feasible and optimal solutions considering health, safety, cultural and environmental factors. **[Problem Solving]**

d) Able to interpret and apply research findings to investigate complex problems using research methodologies. **[Research Skill]**

e) Able to use appropriate techniques, skills, and modern engineering tools necessary for engineering practice. **[Usage of Modern Tools]**

f) Able to work collaboratively in multidisciplinary environments. **[Collaborative and Multidisciplinary work]**

g) Able to apply the principles of management to one's own work to manage projects economically. **[Project Management and Finance]**

h) Able to communicate effectively through written reports and oral presentations. **[Communication]**

i) Able to engage in lifelong learning independently for improved competence. **[Lifelong Learning]**

j) Able to understand professional, ethical and social responsibility. **[Ethical Practices and Social Responsibility]**

k) Able to learn more independently by being active and reflecting on their experiences. **[Independent and Reflective Learning]**

15METE1001 ADVANCED THERMODYNAMICS

Lectures	: 4 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 4		

Prerequisites:

- Engineering mathematics, Basics of Thermodynamics

Course outcomes:

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

- Understand the concept of entropy and apply principles of thermodynamics to analyze advanced power cycles. **(a, b, c, d)**
- Analyze energy systems with Exergy and irreversibility concepts. **(a, b, c)**
- Apply thermodynamic relations for studying the behavior of ideal and real gasses. **(a, b)**
- Apply first and second laws of thermodynamics to analyse chemical reactions. **(a, b, c)**

UNIT I

ADVANCED POWER CYCLES: Binary vapour cycle, co-generation and combined gas-vapour cycle, Thermodynamics of coupled cycles.

ENTROPY: Concept of entropy- Entropy principle-Applications of entropy principle, Entropy change of pure substance, Property diagram involving entropy, Entropy generation in daily life, Entropy change of liquids and ideal gasses, Entropy balance for open and closed systems, Third Law of Thermodynamics.

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

THERMODYNAMIC RELATIONS: Maxwell relations- Tds equations-Difference in Heat Capacities- Ratio of Heat Capacities- Energy Equation- Joule-Thomson's Effect-Clausius Clayperon equation-Evaluation of thermodynamic properties from an equation of state, general thermodynamic considerations on an equation of state.

REAL GASES: Volume Expansivity and Isothermal & Adiabatic compressibility, Real gas behavior and Equations of state – Generalized chart for changes of enthalpy & entropy at constant temperature – Property relations for mixtures.

UNIT IV

CHEMICAL REACTIONS: Combustion, Theoretical and actual combustion processes – Enthalpy of formation – Enthalpy of Combustion – First Law analysis of Reacting Systems – Adiabatic flame temperature – Entropy change of ReactingMixtures – Second Law analysis of Reacting systems – fuel cells and engineering applications.

Text Books:

1. Basic and Applied Thermodynamics - P.K. Nag, 2nd edition, Tata McGraw Hill Education Pvt. Ltd, 2009.
2. Thermodynamics-An Engineering Approach - Yunus A. Cengel M. and Michael A. Boles, McGraw Hill Education (I) Pvt. Ltd, 7th ed., 2011.

References:

1. Thermodynamics - Holman, J.P., 4th Edition, McGraw-Hill Inc.1987
2. Engg. Thermodynamics - Gordon Rogers and Yon Mayhew, Addison Wesley Longman,1999
3. Classical Thermodynamics - Van Wylen, Richard E. Sonntag, 4th Edition, Wiley publication 2005

Web Resources:

- nptel.ac.in/courses/112105123/
- hhttp://www.iscid.org/encyclopedia/Thermodynamics
- http://www.transtutors.com/

15METE1002 ADVANCED HEAT TRANSFER

Lectures	: 4 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 4		

Prerequisites:

- Differential Calculus, Basics of Thermodynamics & Fluid Mechanics

Course Outcomes:

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

- Apply principles of heat conduction in multi-dimensional steady and unsteady state problems. **(a, b, e)**
- Analyze forced convection problems involving complex geometries and boundary conditions.**(a, b, c)**
- Analyze free convection problems for different geometries and ascertain the combined free and forced convection situations. **(a, b, c)**
- Understand the Boiling and Condensation phenomena. **(a, b)**
- Apply the principles of Radiation to find heat exchange between bodies in participating and non participating media. **(a, b, c)**

Course Contents:

UNIT I

2-D STEADY STATE CONDUCTION: Analytical Solution-Method of separation of variables, Numerical Solution- FDM.

TRANSIENT HEAT CONDUCTION: Lumped system analysis, Transient heat transfer in infinite and semi infinite solids, Multidimensional systems, use of Heisler charts.

UNIT II

FORCED-CONVECTION: General review, Analytic solution for friction and heat transfer -laminar flow over a flat plate (Blasius and Pohlhausen solutions), Use of empirical correlations for flow over a flat plate, flow across cylinders and spheres, tube banks – inline and staggered arrangement.

UNIT III

FREE-CONVECTION: Governing equations for free convection laminar boundary layer ona heated vertical plate, Integral method of solution, Use of empirical

correlations for vertical plates, cylinders, horizontal plates, cylinders, spheres and enclosed spaces, Combined free and forced convection.

HEAT TRANSFER WITH PHASE CHANGE: Boiling modes, Pool boiling, flow boiling, Condensation: Nusselt's theory, Film condensation, drop-wise condensation.

UNIT IV

RADIATION: Review of radiation principles - laws of thermal radiation - Surface properties - radiative heat exchange between black and non black surfaces separated by non-participating media.

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

Text Books:

1. Fund. of Heat and Mass Transfer - Incropera, P.P. and Dewitt, D.P., Wiley, 7th ed. 2015
2. Heat and Mass transfer - P.K. Nag, TMH, 3rd ed. 2011.

References:

1. Heat Transfer - A Basic Approach - Ozisik M.N., McGraw-Hill, 3rd ed. 2012.
2. Convective heat and mass transfer - Kays, W.M. and Crawford, M.E., McGraw Hill, 4th ed. 2004.
3. Heat and mass transfer - D.S. Kumar, Kataria & sons, 9th ed. 2015.

***Web Resources**:*

- http://freevideolectures.com/Course/2366/Heat-and-Mass-Transfer
- http://nptel.ac.in/courses/112101097/IIT Bombay
- http://nptel.ac.in/courses/Webcourse-contents/IISc-BANG Heat%20and%20Mass%20Transfer/New_index1.html IISc Bangalore
- http://textofvideo.nptel.iitm.ac.in/112101097/lec1.pdf Prof SP Sukhatme
- http://www.nptelvideos.in/2012/11/heat-transfer.html IIT Gowhati
- https://www.wisc-online.com/learn/natural-science/earth-science/sce304/heat-transfer-conduction-convection-radiation
- http://web.mit.edu/lienhard/www/ahtt.html

NOTE: Heat and Mass Transfer Data Book by Kothandaraman and Subramanian (or) by Domkundwar to be allowed in Examination.

15METE1003 ADVANCED FLUID MECHANICS

Lectures	: 4 + 1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 5		

Prerequisites:

- Differential Calculus, Fluid Mechanics

Course Outcomes:

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

- Derive the governing differential equations of fluid flow. **(a)**
- Determine the laminar flow solutions for flow in pipes, flow between parallel plates and between rotating cylinders. **(a, b, c)**
- Understand the concept of turbulence in pipe flows and analyzing the flows in smooth and rough pipes. **(a, b, c, e)**
- Analyze laminar and turbulent boundary layer flows on a flat plate. **(b, c, e)**
- Analyze the Drag and Lift forces on submerged bodies. **(a, b)**
- Apply the equations of fluid flow for compressible flow in nozzles. **(a, b)**

Course Contents:

UNIT I

FUNDAMENTAL LAWS OF FLUID FLOW: Derivation of general differential equations of fluid flow– continuity, momentum and energy equations- Navier Stokes and Euler equations, Boundary conditions.

LAMINAR INTERNAL FLOWS: Laminar flow between parallel flat plates- Couette-flow, Laminar flow in circular pipes- Hagen–Poiseuille flow, Laminar flow between rotating cylinders. Solutions by elemental approach and solving N-S equations.

UNIT II

TURBULENT INTERNAL FLOWS: Effect of turbulence, types, intensity and scale of turbulence, Reynolds's equations of turbulence, turbulence modeling.Equations for velocity distribution and frictional factor in smooth and rough pipes, friction factor charts - Moody's diagram

FLOW AROUND SUBMERGED BODIES: Drag and Lift coefficients, stream lined and bluff bodies, Drag on a flat plate, cylinder and a sphere, Drag and Lift on an aerofoil.

UNIT III

LAMINAR BOUNDARY LAYER FLOWS: Boundary layers parameters, Prandtl's Boundary Layer Equations, Von karman momentum integral equation and solution to Laminar Boundary layer. Separation of Boundary layer

TURBULENT BOUNDARY LAYER FLOWS: Solution to turbulent boundary layer flows- Power law form and Empirical form, Solution to combine laminar and turbulent flows, Boundary layer separation.

UNIT IV

COMPRESSIBLE FLUID FLOW: Wave Propagation and Sound Velocity, Mach number and Compressible Flow Regimes, Mach Cone, Mach Angle, Mach Line, Basic Equation for One-Dimensional Compressible Flow, Isentropic Flow relations, Compressibility Correction Factor.

COMPRESSIBLE FLOW IN NOZZLES: Area-velocity relations, Nozzles off the design pressure ratio.Effect of viscous friction and heat transfer in compressible flows, in constant area ducts (Fanno equations, Fanno lines, Rayleigh formulas, Rayleigh lines).

Text Books:

1. Fluid Mechanics - Merle C. Potter, David C. Wiggert, Cengage Learning, 4th ed. 2012.
2. Fluid Mechanics-Fundamentals & Applications - Yunus A Cengel and John M. Cimbala, McGraw Hill Publication, 3rd ed. 2010.
3. Fluid Mechanics and Fluid power Engineering - D.S Kumar, Kataria & sons 2015.

References:

1. Fluid Mechanics - Frank M. White, McGraw Hill, 8th ed. 2011.
2. Fundamentals of Compressible Flow - Yahya S.M., New age publications, 4th ed. 2011.
3. Fluid Mechanics -A.K. Mohanty, PHI learning Pvt. Ltd, 2nd ed. 2004.
4. Hydraulics and fluid mechanics - P.N. Modi & S.M. Seth, Rajsons pub. 2004.
5. Advanced Engineering Fluid Mechanics - K. Muralidhar & G. Biswas, Narosa pub. 2nd ed. 2010.

Web Resources:

- http://www.nptel.ac.in/courses/112104118/ui/TOC.htm IIT Kanpur
- http://nptel.ac.in/courses/112105171/1 IIT Kharagpur
- http://nptel.ac.in/courses/105101082/ IIT Bombay
- http://nptel.ac.in/video.php?subjectId=105101082
- http://www.nptelvideos.in/2012/11/fluid-mechanics.html
- http://freevideolectures.com/Course/89/Fluid-Mechanics/1

15METE1004 FINITE ELEMENT ANALYSIS FOR THERMAL ENGINEERING

Lectures	: 4 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 4		

Prerequisites:

- Engineering Mathematics, Fluid Mechanics, Heat Transfer

Course outcomes:

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

- Understand the philosophy of interpolation and convergence **(a, e)**
- Analyze 1-D steady state and transient heat transfer problems **(a, b, c, e)**
- Analyze 2-D steady state heat transfer problems **(a, b, c, e)**
- Formulate 1-D and 2-D fluid kinematics problems **(a, b, c, e)**

Course Contents:

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.

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 II

1-D STEADY-STATE HEAT TRANSFER: FE Formulation using linear and quadratic elements, Numerical problems in composite walls and fins of uniform cross section using linear elements.

1-D TRANSIENT HEAT TRANSFER: Derivation of element matrices, solution techniques, Numerical problem with 2 elements.

UNIT III

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 IV

APPLICATIONS IN FLUID MECHANICS: Finite Element formulation of 1-D and 2-D Steady, incompressible, inviscid, irrotational fluid flows, Problem modeling and boundary conditions.

Text Book:

1. Fundamentals of Finite Element Analysis - David V. Hutton, Tata McGraw Hill, First edition, 2005

References:

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, 7th edition, 2013.

Web Resources:

- https://www.youtube.com/watch?v=xBgWqy49Z_8
- http://www.nptelvideos.in/2012/11/finite-element-analysis.html
- http://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/

15METE1005A MEASUREMENTS IN THERMAL ENGINEERING

Lectures	: 3 + 1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 3		

Prerequisites:

- Basics of Thermodynamics, Fluid Mechanics, Electrical & Electronics

Course outcomes:

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

- Understand the working of basic electrical measuring instruments and analyze errors and uncertainty in measurements. **(a, f)**
- Understand calibration and working of mechanical and low pressure gauges and distinguish different flow measurement techniques. **(a, f)**
- Familiarize with working principles of temperature and thermal transport property measuring instruments. **(a, f)**
- Understand measurement techniques for air pollution and solar radiation. **(a, f)**

Course Contents:

UNIT I

ANALYSIS OF EXPERIMENTAL DATA: Causes and types of experimental errors, Error analysis on a commonsense basis, Uncertainty analysis, Statistical analysis of experimental data probability distributions, Standard deviation of the mean

BASIC ELECTRICAL MEASUREMENTS AND SENSING DEVICES: Transducers –Variable Resistance, The differential transformer (LVDT), Capacitive, Piezoelectric, Photoelectric effects, Photoconductive transducers, Photovoltaic cells, Hall-effect transducers.

UNIT II

PRESSURE MEASUREMENT: Mechanical pressure -Measurement devices, Dead-weight tester, Bourdon-tube pressure gauge, Diaphragm and bellows gauges, Low-pressure measurement. The McLeod gauge, Pirani thermal-conductivity gauge, The Knudsen gauge, the ionization gauge

FLOW MEASUREMENT: Positive displacement methods, flow - Obstruction methods, Practical consideration for obstruction meters, and the sonic nozzle, Flow measurement by Drag Effects, Hot- wire and hot-film anemometers, Magnetic flow meters, Flow visualization methods, smoke methods.

UNIT III

MEASUREMENT OF TEMPERATURE: Ideal-gas thermometer, Temperature measurement by mechanical effect. Temperature measurement by electrical effects, Temperature measurement by radiation, Transient response of thermal systems, Thermocouple compensation.

THERMAL AND TRANSPORT PROPERTY MEASUREMENT: Thermal conductivity measurements, Measurement of viscosity, Gas diffusion, Calorimetry, Humidity measurements, Heat-flux meters.

UNIT IV

AIRPOLLUTION MEASUREMTS: Air–Pollution Standards, General Air sampling Train, Gas Sampling Techniques, Particulate sampling Techniques, Sulfur-dioxide measurements, Combustion Products Measurements, Opacity Measurements, Odor measurements.

THERMAL RADIATION MEASUREMENTS: Detection of thermal Radiation, Measurement of Emissivity, Reflectivity and Transmissivity, Solar radiation measurements.

Text Books:

1. Experimental Methods for Engineers - Holman J.P., TMH, 8th ed., 2012.
2. Mechanical Measurements & Control - D S Kumar, Metropolitan Book Co.

References:

1. Mechanical Measurements - Thomas G. Beckwith, N. Newis Buck
2. Mechanical Measurements - R S Sirohi and Radhakrishnan, New Age Intl.
3. Course in Mechanical Measurements and Instrumentation - A K Sawhney, Dhanapat Rai& Sons.

Web Resources:

- http://nptel.ac.in/downloads/112104039/
- http://web.iitd.ac.in/~pmvs/course_mel705.php

15METE1005B FUELS, COMBUSTION AND EMISSION CONTROL

Lectures	: 3 + 1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 3		

Prerequisites:

- Basics of Thermodynamics, Basic course on IC engines

Course outcomes:

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

- Understand the combustion principles of different fuels. **(a)**
- Understand the combustion systems and combustion kinetics. **(a, b)**
- Understand the functioning of combustion appliances **(a, b, d)**
- Analyze the mechanism of formation of emissions **(a, b, i, j)**

Course Contents:

UNIT I

FUELS: Detailed classification – Conventional and Unconventional Solid, Liquid, gaseous fuels – coal – Carborisation, Gasification and Liquefication – Lignite: petroleum based fuels – problems associated with very low calorific value gases: Coal Gas – Blast Furnace Gas Alcohols and Biogas and Nuclear fuels

PRINCIPLES OF COMBUSTION: Adiabatic flame Temperature – Laminar and turbulent flames propagation and structure – Flame stability – Combustion of fuel, droplets and sprays.

UNIT II

COMBUSTION SYSTEMS: Pulverized fuel furnaces – fixed, Entrained and Fluidized Bed Systems

CHEMICAL KINETICS: Important chemical mechanisms - Simplified conservation equations for reacting flows - Laminar premixed flames - Simplified analysis

UNIT III

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 IV

EMISSIONS: Emission index - Corrected concentrations - Control of emissions for premixed and non-premixed combustion.

ENVIRONMENTAL CONSIDERATIONS: Air pollution – Effects on Environment, Human Health etc. ,Principal pollutants – Legislative Measures.

Text Books:

1. Fuels and combustion, Sharma and Chandra Mohan, Tata McGraw Hill, 3rd Edition, 1987
2. Combustion engineering and Fuel Technology, Shaha A.K, Oxford and IBH, New York, 2003

References:

1. Combustion Fundamentals - Roger A strehlow, McGraw Hill, 1984
2. Principles of Combustion -, Kenneth K.Kuo ,Wiley and Sons, 2nd Edition, 2005
3. An Introduction to Combustion, Concepts and Applications -Turns,S.R.,McGraw Hill, 3rd Edition,2012
4. Fuels and Combustion - Sarkar S,Orient Longman, Orient Blackswan, 1989

Web Resources:

- http://www.nptel.ac.in/courses/103105110/
- fluid.wme.pwr.wroc.pl/.../combustion.../LIQUID_FUEL_COMBUSTION
- www.retscreen.net/links/eeasia_fuels&combustion_chapter.html

15METE1005C NUCLEAR POWR PLANTS

Lectures	: 3 + 1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 3		

Prerequisites:

- Basics of Thermodynamics, Modern physics

Course outcomes:

Atthe end of the completion of the course the student will be able to

- Understand the fundamentals of atomic physics and energy interaction between nuclear particles **(a)**
- Understand the working of various nuclear reactors **(a)**
- Understand the basic fluidized bed reactors and its relevance to Indian Scenario **(a)**
- Understand nuclear fuel handling methods with the concern of health, safety and environmental issues **(a, c)**

Course Contents:

UNIT I

INTRODUCTION TO NUCLEAR ENGINEERING: Introduction - Why Nuclear Power for Developing Countries, Atomic Nuclei, Atomic Number and Mass Number, Isotopes, Atomic Mass Unit, Radioactivity and Radioactive Change Rate of Radioactive Decay, Mass – Energy Equivalence, Binding Energy, Release of Energy by Nuclear Reaction.

TYPES OF NUCLEAR REACTIONS: Initiation of Nuclear Reaction, Nuclear Cross-section, Nuclear Fission, Fission Chain Reaction, moderation, Fertile Materials and Breeding.

UNIT II

NUCLEAR REACTORS: Introduction, General Components of Nuclear Reactor, General Problems of Reactor Operation, Different Types of Reactors, Pressurized Water Reactors (PWR), Boiling Water Reactors (BWR), Heavy Water – cooled and Moderated CANDU (Canadian Deuterium Uranium),Gas-cooled Reactors, Breeder Reactors, Reactor Containment Design,

UNIT III

FLUIDIZED BED REACTORS: Analysis of gas cycle – Steam cycle – Simple and dual pressure cycles – Pebble bed reactors, Liquid metal cooled reactors –

Compatibility with materials - Fast reactors – Fluid fuel reactors – types – Corrosion and Erosion characteristics.

Location of Nuclear Power Plant, Nuclear Power Stations in India, India's 3-stage Program for Nuclear Power Development, Comparison Nuclear Plants with Thermal Plants.

UNIT IV

NUCLEAR MATERIALS: Introduction, Fuels, Cladding and Structural materials Coolants, Moderating and Reflecting materials, Control Rod Materials, Shielding materials.

NUCLEAR WASTE & ITS DISPOSAL: Introduction, Unit of Nuclear Radiation, Types of Nuclear Waste, Effects of Nuclear Radiation, Radioactive Waste Disposal System, Gas Disposal System. SAFETY RULES**:**Personal Monitoring, Radiation Protection, Radiation Dose.

Text Books:

1. Nuclear Power Engineering - El-Wakil M.M., McGraw Hill Co.,New York, 1962.
2. Power Plant Engineering - Arora & Domkundwar, Dhanpat Rai & Co., 2015
3. Combined Power Plants - J.H. Horlock, Pergamon Press,1992.

References:

1. Power Plant Engineering -P.K. Nag, Tata McGraw Hill, 2002.
2. Power Plant Engineering - Black/Veatch, CBS Published & Distributors, 2005.
3. Physics of Nuclear Reactors - Suresh, Tata McGraw hill publishing Co. Ltd., 2005.

Web Resources:

- www.world-nuclear.org/info/inf32.html
- www.energy-sources.com/
- www.nuclear power plants.com

15METE1006A ADVANCES IN I.C. ENGINES

Lectures	: 3 + 1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 3		

Prerequisites:

- Basics of Thermodynamics, I.C. Engines

Course outcomes:

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

- Understand the design and operating parameters of I.C. Engines and fuel Injection Systems. **(a, b)**
- Understand Gas Exchange process and recent engine developments. **(a, d, f)**
- Identify different Alternate fuels based on the need and Properties **(a, b, c, i)**
- Understand Fuel cell and Electric vehicle Technologies, **(a, c, d, f)**

Course Contents:

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.

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

UNIT III

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 IV

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 cells-fuel cell hybrid vehicle-Fuel cell solar vehicle, solar car electrical system, Benefits, fuel regulations.

Text Books:

1. Internal Combustion Engines - V. Ganesan, TMH Pub, 2008.
2. Alternate fuels - SS Thipse - JAICO Publishers, 2010.
3. Alternative Fuel Technology - Erjavec, Arias, Yesdee publications, 2007.

References:

1. Internal combustion engines fundamentals - Heywood J.B., McGraw Hill, 1988.
2. Internal combustion Engines - Mathur & R.P. Sharma, Dhanpat Rai Publications, 2013.
3. Hybrid and Alternative Fuel Vehicles Prentice Hall 4th ed. - James D. Halderman.

Web Resources:

- www.nptel.ac.in/courses/108103009/
- www.nptel.ac.in/courses/103102015/2
- nptel.ac.in/courses/112104033/39
- ocw.mit.edu › ... › Internal Combustion Engines

15METE1006B SOLAR ENGERY UTILIZATION

Lectures	: 3 + 1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 3		

Prerequisites:

- Heat transfer

Course Outcomes:

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

- Understand the utilization of solar radiation & analyse the performance of solar collectors **(a)**
- Design of solar water heating systems **(b, c)**
- Understand types of Thermal energy storage systems and direct energy conversion systems **(a)**
- Understand solar power devices like stills, ponds and Air heaters **(a, j)**

Course Contents:

UNIT I

INTRODUCTION: Solar energy option, specialty and potential – sources of radiation, measurement of beam and diffuse – estimation of average solar radiation on horizontal and tilted surfaces – problems – Applications.

UTILISATION OF SOLAR RADIATION: Physical principles of collection – types – liquid flat plate collectors – construction details – performance analysis – concentrating collection – flat plate collectors with plane reflectors – cylindrical parabolic collectors – Orientation and tracking – Performance Analysis.

UNIT II

SOLAR WATER HEATING SYSTEM: Design of solar water heating system and layout.

POWER GENERATION: Solar central receiver system – Heliostats and Receiver – Heat transport system – solar distributed receiver system – Power cycles, working fluids and prime movers.

UNIT III

THERMAL ENERGY STORAGE: Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage –

Thermo-chemical storage solar pond – working principle – construction – application and limitations.

DIRECT ENERGY CONVERSION: Solid-state principles – semiconductors, Photovoltaic cell – characteristics- cell arrays-power electric circuits for output of solar panels-choppers-inverters-batteries-charge regulators, Construction concepts.

UNIT IV

OTHER SOLAR DEVICES: Stills, ponds, air heaters, dryers.Solar thermal systems applications to power generation, heating and cooling.

Text Books:

1. Solar energy - Sukhatme S.P., TMH., 3rd ed.,2008
2. Solar engineering of thermal processes - Duffie J.A. and Beckman W.A., 4th ed., 2001.
3. Solar energy utilization - G.D. Rai, Khanna Publishers, 4th ed., 2009.

References:

1. Non-conventional Energy resources - S.K. Dubey, S.K. Bhargava,Dhanpatrai publications, 1stEdition, 2009
2. Principles of solar engineering - D.Y. Goswami, F. Kreith and J.F. Kerider, Taylor& Francis publishers,USA, 2nd edition, 2008
3. Fundamentals of solar energy conversion - Edward E.Anderson, 1st Edition, 2014

Web Resources:

- www.renewable-energy-sources.com/

15METE1006C THERMAL STORAGE TECHNOLOGIES

Lectures	: 3 + 1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 3		

Prerequisites:

- Heat Transfer

Course Outcomes:

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

- Understand the basic principles of sensible heat storage systems **(a)**
- Analyze the heat transfer process in regenerative devices **(a, b)**
- Understand the principle of operation of latent heat thermal storage systems **(a)**
- Understand the use of appropriate thermal storage systems for industrial applications **(a)**

Course Contents:

UNIT-I

INTRODUCTION: Thermal Storage necessity, Classification of Energy storage devices, Various Energy Storage technologies & their comparison, storage materials, Seasonal thermal energy storage

BASIC CONCEPT OF SENSIBLE HEAT STORAGE SYSTEM: Modelling of Heat Storage Units, simple water and rock bed Storage Systems- use of TRNSYS Packed beds and pressurized water storage system for power plant applications.

UNIT-II

REGENERATORS: Types – Parallel flow and Counter flow – Finite conductivity model & non-linear model, transient performance, step changes in inlet gas temperature, step changes in gas flow rate, parameterization of transient response-recuperative and regenerative heat exchangers.

UNIT-III

LATENT HEAT STORAGE SYSTEMS: Modeling of phase change problems-temperature based model-enthalpy model porous medium approach-conduction dominated phase change-convection dominated phase change.

UNIT-IV

APPLICATIONS: Specific areas of application of energy storage – food storage - food preservation - waste heat recovery.

Solar energy storage - green house heating - power plant applications-drying and heating for process industries.

Text Books:

1. Thermal Energy storage systems and applications - Ibrahim Dincer & Mark A. Rosen, John Wiley & sons, 1st edition, 1983.
2. J. Duffie, W.Beckman, Solar Engineering of Thermal Processes, John Wiley and Sons In, 4th edition, 2013.
3. H.A.Sorenson, Energy Conversion Systems, John Willey & sons, 2nd edition, 2011.

References:

1. Thermal storage and Regeneration - Schmidt F.W. & Willnot A.J., Hemisphere Pub. Corp.., 1981
2. Heat Transfer in Cold Climates - Lunadini V.J., John Wiley and sons, 1981.
3. Hyman, Lucas B. Sustainable Thermal Storage Systems: Planning, Design, and Operations. New York: McGraw-Hill, 2011.
4. Bansal, K.Leeman, Renewable Energy sources & Conversion Technology, & mellis

Web Resources:

- https://www.irena.org/DocumentDownloads
- http://arena.gov.au/project/advanced-solar-thermal-energy-storage-technologies/

15METE1051 ADVANCED THERMAL ENGINEERING LAB

Practicals	: 3 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 2		

Prerequisites:

- I.C. Engines, Heat Transfer

Course Outcomes:

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

- Evaluate the performance of an I.C. Engine with different fuel blends **(a, c, h, i, k)**
- Measure heat transfer rates in various heat transfer phenomena **(a, c, h, i, k)**
- Evaluate performance of refrigeration & air-conditioning systems **(a, c, h, i, k)**
- Evaluate performance of Renewable energy systems **(a, c, h, i, k)**
- Perform experiments of his/her interest using the available equipment **(d, i, j, k)**

Experiments:

- Bio Fuel testing in CI engines
- Variable Compression Ratio Diesel engine.
- Emission measurement in SI / CI engines.
- Experimental Cooling Tower.
- Transient heat conduction test rig.
- Performance study of a Solar water heater.
- Performance study of a Horizontal axis Wind Turbine.
- Critical heat flux in Pool Boiling.
- Drop wise and Film wise Condensation.
- Vapor Absorption Refrigeration test rig.
- Air conditioning test rig.
- Shell and Tube Heat exchanger.

15METE1052 THERMAL FEM LAB

Practicals	: 3 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 2		

Prerequisites:

- Heat Transfer, Finite Element Method

Course Outcomes:

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

- Analyse and Simulate 1-D, 2-D, 3-D steady state heat conduction problems **(a, c, e, h, i, k)**
- Analyse and Simulate 1-D, 2-D, 3-D Transient problems **(a, c, e, h, i, k)**
- Understand the methodology for accurate solutions **(a, c, e, h, i, k)**
- Analyse and Simulate thermal-structural problems **(a, c, e, h, i, k)**
- Analyse and Simulate Phase change heat situations **(a, c, e, h, i, k)**
- Perform experiments and simulations of interest using the available equipment & software **(d, i, j, k)**

Experiments:

Simulation of different Thermal problems by using ANSYS:

I. Steady State Heat Conduction
   - Variable thermal conductivity,
   - Heat generation,
   - Mixed mode heat transfer,
   - Composite slabs / cylinders / spheres,
   - Three Dimensional Problems

II. Transient Heat Conduction in Plane wall / cylinders / spheres
   - Lumped system Analysis
   - Infinite bodies

III. Structural – Thermal Analysis
   - Thermal Stresses in Hollow cylinders

IV. Heat transfer during Phase change
   - Solidification of Casting

V. Fluid flow Analysis
   - Flow over Flat Plate

15METE2001 GAS TURBINES AND JET PROPULSION

Lectures	: 4 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 4		

Prerequisites:

- Basic &Applied Thermodynamics, Fluid mechanics

Course outcomes:

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

- Describe the characteristics of the ideal cycles and the method of analysis of each cycle. **(a, c)**
- Analyse the performance characteristics of compressors. **(a, b, c)**
- Analyse the performance and applications of gas turbines in power plants. **(a, b, c)**
- Analyse the performance of various jet propulsion systems and devices. **(a, b, c)**
- Understand principle of operation of Rocket propulsion systems. **(a)**

Course contents:

UNIT I

INTRODUCTION: Ideal cycles, Ericsson cycle, Practical cycles and their analysis - compressor and turbine efficiency - pressure losses – cycle efficiency - polytropic efficiency - performance of practical cycle.

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 II

AXIAL FLOW GAS TURBINES: Elementary Theory, Turbine and nozzle efficiencies, Degree of reaction, Impulse turbine analysis, Reaction turbine analysis, comparison of Turbine types.

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 III

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, water-alcohol mixtures, Bleed burn cycle.

UNITIV

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

Text Books:

1. Gas Turbines - Ganesan V., TMH, 3rd Edition, 2010.
2. Gas turbines and propulsive systems - Khajuria P.R., Dubey S.P., Dhanpat Rai pub., 2012.
3. Gas turbines and jet & rocket propulsion - Mathur M.L., Sharma R.P. Standard Publishers, 2011.

References:

1. Gas Turbine Theory - Cohen H, Rogers G and Saravanamuthu H., John Wiley, 2010.
2. Turbines, Compressors and Fans - Yahya S.H, Tata McGraw-Hill. 3rd ed, 2005.
3. Aero-thermodynamics of gas turbine and rocket propulsion - Gordon Oates, AIAA Education series.

Web Resources:

- http://nptel.ac.in/courses/101101002/
- http://nptel.ac.in/courses/112104117/13
- https://powergen.gepower.com/plan-build/products/gas-turbines/index.html

15METE2002 DESIGN OF HEAT TRANSFER EQUIPMENT

Lectures	: 4 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 4		

Prerequisites:

- Fluid Mechanics, Heat Transfer

Course Outcomes:

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

- Apply LMTD and Effectiveness methods in the design of heat exchangers and analyze the performance of double-pipe and shell and tube heat exchanger. **(a, b, c)**
- Understand design of compact heat exchangers and analyse the performance parameters. **(a, b, c)**
- Design condensers and evaporators for various engineering Applications. **(a, d, c)**
- Understand working of different cooling towers and analyse their performance parameters. **(a, b, c)**

Course Contents:

UNIT I

Classification of heat exchangers - basic design methods for heat exchangers - LMTD, ε-NTU, double pipe heat exchangers, parallel and counter flow, multi-pass and cross-flow.

Shell and tube heat exchangers - Basic components, design procedure, Heat transfer and pressure drop; TEMA codes.

UNIT II

Flow arrangements for increased heat recovery, design considerations for different plate type heat exchangers. Compact heat exchangers – types, plate fin, tube fin, Heat transfer and pressure drop.

UNIT III

Different types of condensers -Shell and tube, Steam Turbine Exhaust, plate, air cooled, direct contact condensers. Thermal design of shell and tube condensers, design and operational considerations, condensers for refrigeration and air conditioning, Evaporators for refrigeration and air conditioning, Thermal Analysis.

UNIT IV

Direct contact heat transfer - Classification of cooling towers, wet-bulb and dew point temperatures, Lewis number, cooling-tower internals, heat balance, heat transfer by simultaneous diffusion and convection; Design and analysis of cooling towers, determination of the number of diffusion units, performance evaluation of cooling towers, influence of process conditions and operating variables on their design.

Text Books:

1. Process heat transfer - Donald Kern,
2. Heat Exchangers: Selection, Rating, and Thermal Design - Sadik kakac, Hongtan Liu

References:

1. Heat exchanger design - Press and N. Ozisik
2. Compact Heat exchangers - Kays, W.M., and A.L. London, McGraw Hill.

Web Resources:

- http://nptel.ac.in/courses/103103027/pdf/mod1.pdf
- http://www.ou.edu/class/che-design/design%201-2013/Heat%20Exchangers.pdf

15METE2003 ADVANCED REFRIGERATION AND AIR CONDITIONING

Lectures	: 4 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 4		

Prerequisites:

- Basics of Thermodynamics

Course Outcomes:

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

- Evaluate performance of multi-pressure, multi-load refrigeration systems. **(a, c)**
- Analyze the performance of Vapour Absorption Refrigeration system and familiarize with other refrigeration methods. **(a, c)**
- Estimate the cooling and heating loads for air conditioning systems in residential, commercial and industrial applications. **(a, c)**
- Understand different Low Temperature Production systems. **(a, c)**

Course Contents:

UNIT I

VAPOUR COMPRESSION SYSTEM: Classification of refrigerants,coding of refrigerants, Environmental impact – ODP, GWP, Environment friendly refrigerants.Analysis of Multipressure vapour compression systems – Multi compressor systems and multi evaporator systems.

UNIT II

VAPOUR ABSORPTION SYSTEM: Vapour absorption systems – comparison of absorption with compression system - Analysis of Aqua Ammonia system. Water-LiBr system.

OTHER REFRIGERATION METHODS: Steam jet refrigeration – Thermoelectric refrigeration – Vortex tube refrigeration – Pulse Tuberefrigeration – Magnetic cooling system.

UNIT III

COOLING LOAD CALCULATIONS: Psychrometry– Comfort airconditioning - Factors affecting human comfort – Cooling Load calculations.

UNIT IV

LOW TEMPERATURE PRODUCTION: Low temperatureapplications, Low temperature Insulations, Hazards in Cryogenic Engineering, Joule Thomson Effect, Cascade system, Liquefication of Air – Linde system& Claude system, Liquefication of Hydrogen and Helium.

Text Books:

1. Refrigeration and Air Conditioning - Arora C.P.,Tata McGraw-Hill, 3rd ed., 2008.
2. Refrigeration and Air conditioning - Arora & Domkundwar, Dhanpat Rai & Co. 7th ed., 2008.

References:

1. Refrigeration & Air Conditioning - Stoeker, W.P. Jones, Tata McGraw-Hill, 2nd ed. 2014.
2. Refrigeration and Air Conditioning - Manohar Prasad, New Age Int., 3rd ed., 2014.
3. Principles of Refrigeration - Dossat R.J., Pearson Education,4th ed., 1997.
4. Cryogenic systems - Barron R.F., Oxford University press, 2nd ed., 1985.

Web Resources:

- http://nptel.ac.in/courses/112105128/IIT Chennai
- http://cosmolearning.org/courses/refrigeration-and-airconditioning/

NOTE: Refrigeration and Air-conditioning Data Book allowed in Examination.

15METE2004 COMPUTATIONAL FLUID DYNAMICS

Lectures	: 4 + 1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 5		

Prerequisites:

- Differential Calculus, Fluid Mechanics, Heat Transfer

Course Outcomes:

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

- Apply numerical math to convert PDE's into Finite Difference equations and understand the structured grid generation technique. **(a, d, e)**
- Apply different solution methods for solving parabolic PDE's with stability criterion. **(b, c, d, e)**
- Apply the different solution methods to solve Elliptic and Hyperbolic partial differential eqs. **(b, c, d, e)**
- Formulate and Analyze for the solutions of model Burger's equation and incompressible N-S equations. **(a, b, c, d, e)**

Course Contents:

UNITI:

Philosophy of CFD, Areas of Application, Review of Governing equations of Fluid Dynamics.Classification of Partial Differential equations, initial and boundary conditions.

Finite Difference formulations- 1st order, higher order and mixed derivatives.Grid generation- Structured grids, Algebraic grid generation technique.

UNIT II

Parabolic PDE's: Explicit and Implicit methods, Application to a first order Heat equation, consistency analysis, elementary numerical problems.

Stability Analysis- Von Neumann stability analysis for Heat and first order wave equations, Error Analysis- Numerical dissipation and Dispersion, Modified equation.

UNITIII

Elliptic PDE's: Direct method- Gaussian elimination method, Iterative methods- Jacobi, Gauss-Siedel and Relaxation methods, ADI method, Thomas Algorithm (TDMA), elementary numerical problems.

Hyperbolic PDE's: Explicit and Implicit methods, Multi step methods, Application to a first and second order one dimensional wave equation.

UNITIV

Scalar representation of N-S Equations: Model Burgers equation, different numerical schemes for the Solution of Non linear Burgers equation.

Incompressible N-S equations: Governing equations, Pressure Correction Method, Staggered Grid, SIMPLE algorithm, Boundary conditions for PCM. Vorticity-Stream function formulation, Boundary conditions, Modeling of Rectangular cavity problem.

Text Books:

1. Computational Fluid Dynamics - Basics with Applications - John. D. Anderson, JR. McGraw Hill Education (India) Edition 2012.
2. Computational Fluid Dynamics - T. J. Chung, Cambridge University Press, 2nd Edition, 2014.

References:

1. Introduction to computational fluid mechanics - Niyogi, Chakravarty, Laha, Pearson pub. 1st ed. 2009.
2. Numerical heat transfer and fluid flow - S.V. Patankar, Hemisphere Pub. 1st ed.
3. Computational Fluid flow and Heat transfer - K. Muralidhar and T. Sundararajan, Narosa Pub. 2nd ed. 2003.

Web Resources:

- http://ocw.mit.edu/courses/mechanical-engineering/2-29-numerical fluid-mechanics-fall-2011/
- http://nptel.ac.in/courses/112105045/(IIT Kharagpur)
- http://nptel.ac.in/courses/112107080/(IIT Roorkee)
- http://nptel.ac.in/courses/112104030/(IIT Kanpur)
- http://www.nptelvideos.in/2012/11/computational-fluid-dynamics.html (IIT Madras)
- http://www.cfd-online.com/

15METE2005A RENEWABLE ENERGY SYSTEMS

Lectures	: 3 + 1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 3		

Prerequisites:

- Thermodynamics,Heat Transfer

Course Outcomes:

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

- Use the knowledge of solar energy conversion techniques and calculate conversion efficiency **(a, b, c)**
- Design wind and geothermal energy systems that are economically feasible and ecofriendly **(c, j)**
- Understand working of ocean thermal, tidal and wave energy power plants **(a)**
- Understand major components of various fuel cell and Biomass energy conversion systems **(a, b)**

Course Contents:

UNIT I

SOLAR ENERGY: Availability of solar energy, Measurement of sunshine, solar radiation data, estimation of average solar radiation, solar energy selection, selective surfaces, Construction of solar flat plate and evacuated tube collectors, Solar heating and cooling.

PHOTO VOLTAIC ENERGY: Solar cells - Photovoltaic conversion efficiency, Performance characteristics of solar cells as a function of light intensity, temperature and cell area, Solar cell response under normal condition, solar cell arrays.

UNIT II

WIND ENERGY: wind mills and wind turbine systems, Classification of wind machines: Horizontal & Vertical axis configuration. High and low solidity rotors, Elements of wind mills and wind turbine systems, Aerodynamic models, Rankine Froud Actuator disc model.

GEOTHERMAL ENERGY: Earth as source of heat energy, stored heat and renewability of earth's heat, Nature and occurrence of geo thermal field, Classification of thermal fields, Model of Hyper thermal fields & Semi thermal fields.

UNIT III

OCEAN THERMAL ENERGY: Ocean thermal energy sources, Ocean thermal energy power plant development, Closed and open cycles, advantages and operating difficulties.

TIDAL & WAVE ENERGY: Tidal power sources, Conventional and latest design of tidal power system, the ocean wave, oscillating water column (Japanese) and the Dam.

UNIT IV

FUEL CELL ENERGY: Description, properties and operation of fuel cells, Major components & general characteristics of fuel cells, Description of low power fuel cell systems and molten carbonate fuel cell systems.

BIOMASS ENERGY: Types of conversion techniques for the production of solid, liquid and gaseous fuels by chemical and biochemical methods - Technology of biogas, - Principles and feed stock Design of bio-gas plants.

Text Books:

1. Renewable Energy Sources - Twidell J.W. & Weir, A., EFN Spon Ltd., UK., 2nd Edition, 1986
2. Non-Conventional Energy Sources - G.D. Rai, Khanna Publishers, New Delhi, 4th edition,2009

References:

1. Solar Energy - S.P. Sukhatme, Tata McGraw Hill Pub. Co. Ltd., 3rd Edition, 2008
2. Wind Energy Systems - Johnson Gary L., Prentice Hall, New York., 2nd Edition,1995
3. Biomass Regenerable energy - Hall D.D. & Grover R.P., John Wiley., 1st edition,1989
4. Renewable energy sources & conversion technology - Leemann & Meliss, TMH., 4th edition,1993
5. Non –conventional energy Resources-S.Hasan Saeed,D.K.Sharma, Publishers-S.K.Kataria &Sons, 3rd Edition, 2012

Web Resources:

- www.renewable-energy-sources.com/

15METE2005B HYDROGEN AND FUEL CELL TECHNOLOGIES

Lectures	: 3 + 1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 3		

Course Outcomes:

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

- Understand the methods of hydrogen production, storage & its applications **(a)**
- Understand the basic principles of electrochemical power generation systems **(a, f)**
- Understand the knowledge on different types of fuel cells **(a, f)**
- Attain the knowledge on economic analysis of fuel cells, applications and future trends. **(a, f, i, j, k)**

Course Contents:

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.

HYDROGEN STORAGE AND ITS APPLICATIONS: Hydrogen storage options-compressed gas-liquid hydrogen-Hydride-chemical storage-safety and management of hydrogen, applications of hydrogen.

UNITII

FUEL CELLS: History- Principles- working-thermodynamics and kinetics of fuel cell process Performance evaluation of fuel cell – Comparison of battery Vs fuel cell.

UNIT III

TYPES OF FUEL CELLS: AFC, PAFC, SOFC – relative merits and demerit

MCFC,DMFC, PEMFC – relative merits and demerits

UNITIV

APPLICATIONS OF FUEL CELLAND ECONOMICS: Usage of fuel cell 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

Text Books:

1. Fuel Cells - Principles and Applications - Viswanathan B. & M. Aulice Scibich, Universities press
2. Hydrogen and Fuel Cells - A comprehensive guide - Rebecca.L. and Busby, Premwell corporation

References:

1. Hydrogen and Fuel cells Emerging Technologies and Applications - Bent Sorensen, Elsevier (UK)
2. Fuel Cell and Their applications - Kordesch. K. & G. Simader, Wiley, Germany
3. Fuel Cells Theory & Applications - Hart A.B. & G.J. Womack, Prentice Hall, New York

Web Resources:

- NPTEL http://nptel.iitm.ac.in
- www.renewableenergyworld.com/hydrogen/tech.html

15METE2005C CRYOGENICS

Lectures	: 3 + 1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 3		

Prerequisites:

- Basic Thermodynamics, Heat Transfer, Refrigeration

Course outcomes:

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

- Understand the mechanism of variation of properties of materials at low temperatures **(a)**
- Apply the principles of thermodynamics to analyze the low-temperature air separation systems.**(a, b, c)**
- Apply the principles of thermodynamics to the analyze gas liquefaction systems. **(a, b, c)**
- Understand use of effective and environmentally safe cryogenic technology for applications in industry, construction, agriculture, medicine and living organisms. **(a, f, j)**

Course contents:

UNIT I

Introduction: Historical development – present areas involving cryogenic engineering. Basic thermodynamic as applied to liquefaction and refrigeration process – isothermal, adiabatic and Joule Thomson expansion process –

Low temperature properties of engineering materials: Mechanical properties – thermal properties – electrical and magnetic properties. Properties of cryogenic fluids

UNIT II

Gas liquefaction systems: Production of low temperatures - general liquefaction systems – liquefaction systems for neon, hydrogen, nitrogen and helium.

Gas separation systems: Thermodynamically ideal separation systems, Simple condensation or evaporation, Rectification, Rectifying columns – packed columns, plate columns.

UNIT III

Cryogenic refrigeration systems: ideal refrigeration systems – refrigerators using liquids and gases as refrigerants – refrigerators using solids as working media.

Air separation systems: Linde-single column system, Linde-double column system Linde-Frankl system, Heylands system.

UNIT IV

Cryogenic storage and transfer systems: Cryogenic fluid storage vessels, cryogenic fluid transfer systems.

Application of cryogenics: Cryo pumping – Superconductivity and super fluidity – cryogenics in space technology – cryogenics in biology and medicine.

Text Book:

1. Cryogenic Systems - Randall F. Barron, Second edition, McGraw Hill.1966

References:

1. Cryogenics Engineering - Scott R.B., D. Van Nostrand Company, Princeton, NJ, 1959
2. Cryogenic Technology - Herald Weinstock, Boston Technical Pub.inc., 1969
3. Applied Cryogenic Engineering - Vance, R. W. and Duke, W. M., John Wiley.1962
4. Cryogenic Process Engineering - Timmerhaus K. D. and Flynn T. M., Plenum Press.1989

Web Resources:

- http://nptel.ac.in/courses/112101004/
- https://books.google.co.in/books?isbn=038746896X
- https://books.google.co.in/books?isbn=1461398681

15METE2006A ENERGY CONSERVATION & MANAGEMENT

Lectures	: 3 + 1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 3		

Prerequisites:

- Industrial Management, Energy Economics

Course Outcomes:

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

- Understand objectives and Role of Energy Management in Manufacturing & Process industries **(a, e, f, g)**
- Identify the need for Energy conservation methods and understand Energy usage options, waste heat recovery systems and Applications.**(a, c, f, g, j)**
- Illustrate Energy Audits with graphical techniques **(b, g, h)**
- Understand the scope and need of Economic Analysis, Investment Projects, Depreciation, Budget and Risk analysis **(g, j, k)**

Course Contents:

UNIT - I

Energy policy, planning and implementation: Principles of Energy Management – Managerial Objectives – Energy Management in Functional Areas like Manufacturing Industry, Process Industry, Commerce – Role of Energy Manager in each of these organizations. Initiating, Organizing and Managing, Energy Management Programs.

UNIT II

Energy Conservation: Technologies for Energy Conservation, Design for Conservation of Energy materials – energy flow networks – critical assessment of energy usage – formulation of objectives and constraints – synthesis of alternative options and technical analysis of options.

Waste Heat Recovery: Sources of waste heat and its potential applications, Heat recovery equipments and systems, Heat Exchangers, Incinerators, Regenerators and Recuperates, Waste Heat boilers.

UNITIII

Energy Audit: Definition and Concepts, Types of Energy Audits – Basic Energy Concepts – Resources for Plant Energy Studies – Data Gathering – Analytical Techniques.

Energy Consultant: Need of Energy Consultant – Consultant Selection Criteria - Energy Regulatories.

UNITIV

Economic Analysis: Scope, Characterization of an Investment Project – Types of Depreciation – Time Value of money – budget considerations, Risk Analysis.

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 methods of analysis – replacement analysis.

Text Books:

1. Energy Management - W.R. Murphy and G. Mc Kay, Butterworth-Heinemann, 1981.
2. Energy Management Principles - CB Smith, Pergamon, 1981.

Reference Books:

1. Energy Management Hand book - W.C. Turner, CRC Press, 2007
2. Management - H. Koontz and Cyrill O Donnell, Mc. Graw Hill, 1980.
3. Financial Management - C. Kuchhal, TMG, 2009
4. Financial Management - I M Panday, Vikas Publishing House, 9th edition, 2005.

Web Resources:

- www1.iitb.ac.in/~cep/about/index.html
- nptel.ac.in/courses/108106022/
- https://www.energyinst.org/training/energy-management-courses/e-learni.
- http://ocw.mit.edu/courses/energy-courses/

15METE2006B ENVIRONMENTAL ENGG. & POLLUTION CONTROL

Lectures	: 3 + 1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 3		

Course Outcomes:

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

- Understand the sources of pollution and their effects **(a, j)**
- Understand water pollution treatment methods and principles of waste management **(a, c, j)**
- Understand EMS certification procedures and Environmental audit **(a, h, j)**
- Understand the importance of EIA and Environmental protection Laws **(a, j)**

Course Contents:

UNIT I

Introduction: Global Atmospheric change – Green House effect – Ozone depletion – natural cycles – mass and energy transfer – material balance – environmental chemistry and biology - impacts – environmental Legislations. Air pollution, pollutants – sources and effect – air pollution meteorology atmospheric dispersion

UNIT II

Water pollution: Sater resources – water pollutants – characteristic water treatment systems – waste water treatment – utilization and disposal of sludge

Waste management: Sources and classification – solid waste – Hazardous Waste – characteristics – collection and transportation – disposal

UNIT III

Environmental Management systems: Introduction, Evolution of ISO 14000: Background step by step preparation of EMS certification, ISO 14001: EMS, Basic ISO 14004 Guidance Document, ISO 14010 Audit standards, ISO 14020 Labeling Standards.Environmental Audit, Introduction – Range of Audit objectives – prevailing practices – Audit Methodology, Benefits of E. A.

UNIT IV

Environmental Impact Assessment (E.I.A): Introduction – Methodology of E. I. A. – organizing the job- performing the assessment – preparation of E.I. Statement,

Role of E.I.A. in sustainable development, E.I.A. of hazardous waste - Limitations of E.I.A. – case study.

Environmental Legislation: Introduction – Environment Protection Law in India, WaterAct 1974 – Air Act 1981 – Wild Life Protection Act 1972 – Indian Forest Act 1927 – Environmental Act 1986 - Motor Vehicle Act 1988. Pollution Control Boards (PCBs) – Activities Current Issues - Miscellaneous Topics – Tragic Incidents.

Text Books:

1. Environmental Engineering and Management - Dr. Suresh, K Dhameja, S.K. Kataria & Sons Pub. 6th Edition 2012.
2. Environmental Pollution control Engineering - C.S. Rao, New Age Intl. Pvt. Ltd. 2010.

References:

1. Waste Water Treatment - G.L. Karia & R. A. Christian, Prentice Hall (I) Pvt. Ltd., 2009
2. Environmental Engineering - G. N. Pandey & G. C Karney, Tata McGraw Hill, 2004.
3. Environmental Impact Assessment - M. Anji Reddy, B.S. Publications, Hyderabad, 7th Ed. 2011
4. Environmental Science & Engineering - Venugopala Rao, Prentice Hall (I) Pvt. Ltd., 2008.

15METE2006C GAS DYNAMICS

Lectures	: 3 +1 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 3		

Prerequisites:

- Fluid Mechanics,Heat Transfer

Course Outcomes:

At the completion of course the student will be able to

- Understand the physics behind the concepts of wave propagation. **(a)**
- Formulate and solve problems in 1D steady compressible flows & 2D Compressible flows. **(a, c)**
- Analyse the flow parameters through normal shock waves and strength of shock waves on wedge shaped bodies and concave corners. **(a, b, c)**
- Evaluate the flows with friction and heat transfer by Fanno and Rayleigh relations. **(a, c)**

Course Contents:

UNIT I

Basic Equation of compressible Flow: Application of general differential equation of continuity, momentum & energy to compressible inviscid fluids; Compressible Bernoulli's equation, Irrotational flow, Velocity potential & Stream function.

Wave propagation: Wave propagation, Velocity of Sound, Subsonic and Supersonic Flow.

UNIT II

Steady one dimensional Flow: Fundamental Equations, Discharge from a Reservoir, Stream-tube, Area–Velocity Relation, De-Laval Nozzle, diffusers, dynamic head, Measurement in Compressible Flow, Pressure Coefficient.

Two–Dimensionalcompressible Flow: General linear solution for supersonic Flow, flow along Wave- Shaped Wall.

UNIT III

Normal Shock Waves: Equation of Motion for normal shock waves, the normal shock Relations, total pressure across the shock wave, Hugoniot equation, propagating shock wave, reflected shock wave, shock tube.

Oblique shock waves: Oblique shock Relations, Prandtl's equation, Hugoniot equation, variation of flow parameters, oblique shock Relations from the normal shock equation, Mach waves.

UNIT IV

Flow with Friction: Flow in constant Area duct with friction, Adiabatic, Constant – Area Flow of a Perfect Gas, The Fanno curves. Solution of Fanno flow equations, variation of flow properties, tables and charts for Fanno Flow.

Flow with Heat Transfer: flow with Heating or cooling in ducts, Rayleigh line, Fundamental equations, Rayleigh flow relations, variation of flow properties, Maximum heat transfer, tables and charts for Rayleigh flow.

Text Books:

1. Fundamentals of compressible flow - S.M.Yahya, New Age Int., 4th ed., 2012.
2. Gas Dynamics – E. Rathakrishnan, PHI Learning Pvt. Ltd, 5th ed., 2013.

References:

1. Kinetic Theory and Gas Dynamics - Carlo Cercignani, Springer Verlog, 1988.
2. Elements of Gas Dynamics - Liepmann, Dover Publication, 1st ed. 2001.
3. Gas Dynamics:Multidimensional Flow VolI & II - Zucrow M.J. and Hoffman J.D., John Wiley.

Web Resources:

- http://nptel.ac.in/courses/112106056/
- https://www.youtube.com/playlist?list=PLF1779EDE134553BB
- http://www.learnerstv.com/Free-Engineering-Video-lectures-ltv837-Page1.htm
- http://web.mit.edu/hml/ncfmf.html

15METE2007 ENGINE EMISSION CONTROL
(Self Learning Course)

Internal Assessment : 40

Credits : 2 Semester end Examination : 60

Prerequisites:

- Basics of I.C. Engines

Course Outcomes:

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

- Understand various I.C. Engine cycles and testing procedures for engine emissions. **(a, c, i, j)**
- Understand the Mechanism of pollutant formation in SI Engines, influence of fuel properties on pollutant formation and control measures. **(a, c, i, j)**
- Understand the Mechanism of pollutant formation in CI Engines, influence of fuel properties on pollutant formation and control measures. **(a, c, i, j)**
- Understand the Combustion phenomena and treatment of emissions for enhancing performance of engine. **(a, c, i, j)**

Course Contents:

UNITI

Laws and Regulations, Regulatory Test Procedures, Test Cycles, Exhaust Gas Pollutants,Particulate Pollutants, Evaporative Emissions, Blow by Emissions, Emissions from two Wheelers and Two Stroke Engines.

UNIT II

Mechanism of pollutant formation in SI Engines, formation of nitrogen oxides, formation of carbon monoxide, formation of unburnt hydrocarbons, formation of particulates, formation of PAH and nitrated derivatives, Influence of Fuel Properties, Pollution Control Measures inside the engine and Lean Burn Engines.

UNIT III

Mechanism of pollutant formation in IDI and DI Diesel Engines, Formation of Nitrogen Oxides,Formation of carbon monoxide, formation of unburnt hydrocarbons, formation of particulates, formation of PAH and nitrated derivatives. Influence of Fuel properties. Pollution Control Measures inside the engine, HCCI (Homogeneous Charged Compression Ignition) and CCS (Combine Combustion system) Engines.

UNIT IV

Post Combustion Treatments, Physical Conditions and Exhaust Gas composition, Catalytic mechanism of CO Oxidation, unburnt hydrocarbon oxidation and nitrogen oxide reduction, Dual catalysis, three way catalysis,thermal reactors, catalyst structures. Installation of catalyst, Oxidation catalyst, Particulate Matter, NOx Trade off in Diesel engines, Diesel Trap Oxidizers.

References:

1. Automobiles & Pollution - P. Degobert, SAE, 1996.
2. I.C. Engines Fundamentals - J.B. Heywood, McGraw Hills Intl. Std. Ed.

Web Resources:

- http://nptel.ac.in/Clarify_doubts.php?subjectId=112104033&lectureId=1
- http://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2008/lecture-notes/
- http://www.nitc.ac.in/dept/me/jagadeesha/Internal_Combustion_Engines/Chapter5.pdf
- https://books.google.co.in/books?ENGINE+EMISSION+CONTROL+COURSE&source=bl
- https://books.google.co.in/books?id=M8w5yJbNTD0C&pg=PA271&dq=engine+emission+control

15METE2051 FLUID DYNAMICS LAB

Practicals	: 3 Periods / Week	Internal Assessment	: 40
Semester end Exam	: 3 hrs	Semester end Examination	: 60
Credits	: 2		

Prerequisites:

- Fluid Mechanics, Heat Transfer, CFD Software.

Course Outcomes:

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

- Perform experiments individually and in groups to determine the aerodynamic behavior of stream lined and bluff bodies.**(b, f, k)**
- Determine the pressure distribution on symmetric and unsymmetrical airfoils and on cylinder. **(b, e, k)**
- Evaluate Drag and Lift coefficients under different flow conditions. **(b, e, k)**
- Simulate the different fluid flows using CFD software. **(b, c, e, k)**
- Report the results generated in a systematic manner. **(h, j)**
- Interpret the theoretical, numerical and experimental results of the problems and arriving at reasonable conclusions. **(d, h, i, k)**
- Perform experiments and simulations of his/her interest using the available equipment and software.**(d, i, j, k)**

Course Contents:

Wind Tunnel experiments on

- Aerofoil / Cylinder / Sphere / Bluff bodies etc..

Simulation of fluid flows

- Poisuille flow / Couette flow
- Tube and Nozzle flows
- Flow over a flat plate
- Flow over aerofoils / cylinders

Web Resources:

- Wind Tunnel Supplier manual
- ANSYS v 15.0 manual
- http://www.ansys.com/Support/Training+Center/Courses/Introduction+to+ANSYS+FLUENT
- http://iidesign.co.in/ansys_fluent_software_course.php
- http://imechanica.org/node/15400

15METE2052 MINI-PROJECT & SEMINAR

Practicals	: 3 Periods / Week	Internal Assessment	: 40
Semester end Exam	: Viva-voce	Semester end Examination	: 60
Credits	: 2		

- Identify simple theoretical and practical problems related to the area of program specialization. **(a, d)**
- Analyse / Solve theoretical / practical problems for arriving at feasible solutions. **(b, c, d, k)**
- Prepare an organized report employing elements of technical writing and critical thinking. **(b, h, i, j)**
- Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting. **(h, k)**

15METE3051 MAJOR PROJECT-A

Credits	: 10	Internal Assessment	: 40
Semester end Exam	: Viva-voce	Semester end Examination	: 60

- Identify a topic in relevant areas of thermal engineering. **(a, d)**
- Review literature to identify gaps and define objectives & scope of the work. **(a, b, d)**
- Understand the methods and processes from literature and apply appropriate research methodologies. **(b, d)**
- Develop a model, experimental set-up and / or computational techniques necessary to meet the objectives. **(b, c, e, g, i)**

15METE4051 MAJOR PROJECT-B

Credits	: 14	Internal Assessment	: 40
Semester end Exam	: Viva-voce	Semester end Examination	: 60

- Identify methods and resources to carry out analysis and experiments. **(b, c, e, f, g)**
- Reorganize the procedures with a concern for society, environment and ethics. **(g, j)**
- Analyze and discuss the results to draw valid conclusions. **(b, h, i, k)**
- Prepare a report as per the recommended format and defend the work and explore the possibility of publishing the work. **(h, i, j)**