ANNAMALAI UNIVERSITY

WITH COURAGE AND FAITH

Faculty of Engineering and Technology

M.E. THERMAL POWER ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

Hand Book

2017

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

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

MISSION

The Mechanical Engineering program makes available a high quality, relevant engineering education. The Program dedicates itself to providing students with a set of skills, knowledge and attitudes that will permit its graduates to succeed and thrive as engineers and leaders. The Program strives to:

- Prepare its graduates to pursue life-long learning, serve the profession and meet intellectual, ethical and career challenges.
- Maintain a vital, state-of-the-art research enterprise to provide its students and faculty with opportunities to create, interpret, apply and disseminate knowledge.

Programme Educational Objectives (PEO)

1. To equip the students with necessary foundation for effectively analyzing and solving the problems associated in thermal engineering field.
2. To deliver comprehensive education in thermal Engineering to ensure that the students have core competency to be successful in industry/ research laboratory and motivate them to pursue higher studies and research in interrelated areas.
3. To encourage the students to take up real life and/or research related problems and to create innovative solutions of these problems through comprehensive analysis and designing.
4. Graduates will have inculcated the ability to maintain high professionalism and ethical standards, effective technical presentation and writing skill and to work as a part of team on research projects

Program Outcomes (PO)

PO 1: An ability to acquire, apply and share in-depth knowledge in the area of thermal engineering.

PO 2: An ability to conduct independent research and generate new knowledge for the benefit of mankind.

PO 3: Graduates will demonstrate an ability to identify, formulate and solve thermal engineering problems.

PO 4: Graduates will demonstrate research skills to critically analyze complex thermal engineering problems for synthesizing new and existing information for their solutions.

PO 5: An ability to maintain a high level of professional and intellectual integrity, ethics of research and scholarly standards.

PO 6: Graduates will demonstrate skills to use modern engineering tools, software and equipment to analyze and solve complex engineering problems.

PO7: Graduates will demonstrate and ability to work on laboratory and multidisciplinary tasks.

PO 8: Students will be able to convey thoughts effectively on the basis of acquired soft skills and self confidence with peers, subordinates and higher authority for the consistent and effective knowledge sharing process.

PO 9: Graduates will be able to understand the need for, and an ability to engage in life-long learning and continual updating of professional skills

PO 10: Graduate will acquire knowledge about current issues/advances in engineering practices.

Mapping PO with PEO										
POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
PEO1		✓	✓	✓		✓				✓
PEO2	✓	✓	✓				✓		✓	✓
PEO3		✓		✓		✓	✓	✓	✓	✓
PEO4	✓		✓	✓	✓	✓		✓		✓

ANNAMALAI UNIVERSITY
FACULTY OF ENGINEERING AND TECHNOLOGY
M.E. / M. Tech (Two-Year Full Time & Three-year Part Time)

DEGREE PROGRAMME

CHOICE BASED CREDIT SYSTEM (CBCS)

REGULATIONS

1. **Condition for Admission**
   Candidates for admission to the first year of the four-semester **M.E / M.Tech Degree programme in Engineering** shall be required to have passed B.E / B.Tech degree of Annamalai University or any other authority accepted by the syndicate of this University as equivalent thereto. They shall satisfy the condition regarding qualifying marks and physical fitness as may be prescribed by the syndicate of the Annamalai University from time to time. The admission for part time programme is restricted to those working or residing within a radius of **90 km** from Annamalainagar. The application should be sent through their employers.

2. **Branches of Study in M.E / M.Tech**
   The Branch and Eligibility criteria of programmes are given in **Annexure 1**

3. **Courses of study**
   The courses of study and the respective syllabi for each of the M.E / M. Tech programmes offered by the different Departments of study are given separately.

4. **Scheme of Examinations**
   The scheme of Examinations is given separately.

5. **Choice Based Credit System (CBCS)**
   The curriculum includes three components namely Professional Core, Professional Electives and Open Electives in addition to Thesis. Each semester curriculum shall normally have a blend of theory and practical courses.

6. **Assignment of Credits for Courses**
   Each course is normally assigned one credit per hour of lecture / tutorial per week and one credit for two hours or part thereof for laboratory or practical per week. The total credits for the programme will be 65.

7. **Duration of the programme**
   A student of **M.E / M.Tech** programme is normally expected to complete in four semesters for full-time / six semesters for part-time but in any case not more than four years for full-time / six years for part-time from the date of admission.

8. **Registration for courses**
   A newly admitted student will automatically be registered for all the courses prescribed for the first semester, without any option. Every other student shall submit a completed registration form indicating the list of courses intended to be credited during the next semester. This registration

will be done a week before the last working day of the current semester. Late registration with the approval of the Dean on the recommendation of the Head of the Department along with a late fee will be done up to the last working day. Registration for the Thesis Phase - I and II shall be done at the appropriate semesters.

9. Electives

The student has to select two electives in first semester and another two electives in the second semester from the list of Professional Electives. The student has to select two electives in third semester from the list of Open Electives offered by the department/ allied department. A student may be allowed to take up the open elective courses of third semester (Full Time program) in the first and second semester, one course in each of the semesters to enable them to carry out thesis in an industry during the entire second year of study provided they should register those courses in the first semester itself. Such students should meet the teachers offering those elective courses themselves-for clarifications. No specific slots will be allotted in the time table for such courses.

Further, the two open elective courses to be studied in III semester (Full Time programme) may also be credited through the SWAYAM portal of UGC with the approval of Head of the Department concerned. In such a case, the courses must be credited before the end of III Semester.

10. Assessment

The break-up of continuous assessment and examination marks for theory courses is as follows:

First assessment (Mid-Semester Test-I)	:	10 marks
Second assessment (Mid-Semester Test-II)	:	10 marks
Third Assessment	:	5 marks
End Semester Examination	:	75 marks

The break-up of continuous assessment and examination marks for Practical courses is as follows:

First assessment (Test-I)	:	15 marks
Second assessment (Test-II)	:	15 marks
Maintenance of record book	:	10 marks
End Semester Examination	:	60 marks

The thesis Phase I will be assessed for 40 marks by a committee consisting of the Head of the Department, the guide and a minimum of two members nominated by the Head of the Department. The Head of the Department will be the chairman. The number of reviews must be a minimum of three per semester. 60 marks are allotted for the thesis work and viva voce examination at the end of the third semester. The same procedure will be adopted for thesis Phase II in the fourth semester.

11. Student Counsellors (Mentors)

To help the students in planning their course of study and for general advice on the academic programme, the Head of the Department will attach a certain number of students to a member of the faculty who shall function as student counsellor for those students throughout their period of study. Such student counsellors shall advise the students, give preliminary approval for the courses to be taken by the students during each semester, monitor their progress in

SWAYAM courses / open elective courses and obtain the final approval of the Head of the Department.

12. Class Committee

For each of the semesters of M.E / M.Tech programmes, separate class committees will be constituted by the respective Head of the Departments. The composition of the class committees from first to fourth semesters for Full time and first to sixth semesters for Part-time will be as follows:

- Teachers of the individual courses.
- A Thesis coordinator (for Thesis Phase I and II) shall be appointed by the Head of the Department from among the Thesis supervisors.
- A thesis review committee chairman shall be appointed by the Head of the Department
- One Professor or Associate Professor, preferably not teaching the concerned class, appointed as Chairman by the Head of the Department.
- The Head of the Department may opt to be a member or the Chairman.
- All counselors of the class and the Head of the Department (if not already a member) or any staff member nominated by the Head of the Department may opt to be special invitees.

The class committee shall meet **three** times during the semester. The first meeting will be held within two weeks from the date of class commencement in which the type of assessment like test, assignment etc. for the third assessment and the dates of completion of the assessments will be decided.

The second meeting will be held within a week after the completion of the first assessment to review the performance and for follow-up action.

The third meeting will be held after all the assessments but before the University semester examinations are completed for all the courses, and at least one week before the commencement of the examinations. During this meeting the assessment on a maximum of 25 marks for theory / 40 marks for practical and project work will be finalized for every student and tabulated and submitted to the Head of the Department for approval and transmission to the Controller of Examinations.

13. Temporary Break Of Study

A student can take a one-time temporary break of study covering the current semester and / or the next semester with the approval of the Dean on the recommendation of the Head of the Department, not later than seven days after the completion of the mid-semester test. However, the student must complete the entire programme within the maximum period of **four years for Full time / six years for Part time.**

14. Substitute Assessments

A student who has missed, for genuine reasons accepted by the Head of the Department, one or more of the assessments of a course other than the end of semester examination may take a substitute assessment for any one of the missed assessments. The substitute assessment must be completed before the date of the third meeting of the respective class committees.

A student who wishes to have a substitute assessment for a missed assessment must apply to the Head of the Department within a week from the date of the missed assessment.

15. Attendance Requirements

The students with 75% attendance and above are permitted to appear for the University examinations. However, the Vice Chancellor may give a rebate / concession not exceeding 10% in attendance for exceptional cases only on Medical Grounds.

A student who withdraws from or does not meet the minimum attendance requirement in a semester must re-register and repeat the same semester in the subsequent academic years.

16. Passing and declaration of Examination Results

All assessments of all the courses on an absolute marks basis will be considered and passed by the respective results passing boards in accordance with the rules of the University. Thereafter, the controller of examinations shall convert the marks for each course to the corresponding letter grade as follows, compute the grade point average (GPA) and cumulative grade point average (CGPA) and prepare the mark sheets.

90 to 100 marks	Grade 'S'
80 to 89 marks	Grade 'A'
70 to 79 marks	Grade 'B'
60 to 69 marks	Grade 'C'
55 to 59 marks	Grade 'D'
50 to 54 marks	Grade 'E'
Less than 50 marks	Grade 'RA'
Withdrawn from the Examination	Grade 'W'

A student who obtains less than 30 / 24 marks out of 75 / 60 in the theory / practical examinations respectively or is absent for the examination will be awarded grade RA.

A student who earns a grade of S, A, B, C, D or E for a course is declared to have successfully completed that course and earned the credits for that course. Such a course cannot be repeated by the student.

A student who obtains letter grade RA / W in the mark sheet must reappear for the examination of the courses.

The following grade points are associated with each letter grade for calculating the grade point average and cumulative grade point average.

S - 10; A - 9; B - 8; C - 7; D - 6; E - 5; RA - 0

Courses with grade RA / W are not considered for calculation of grade point average or cumulative grade point average.

A student can apply for re-totaling of one or more of his examination answer papers within a week from the date of issue of mark sheet to the student on payment of the prescribed fee per paper. The application must be made to the Controller of Examinations with the recommendation of the Head of the Department.

After the results are declared, mark sheets will be issued to the students. The mark sheet will contain the list of courses registered during the semester, the grades scored and the grade point average for the semester. GPA is the sum of the products of the number of credits of a course with the grade point scored in that course, taken over all the courses for the semester, divided by the sum of the number of credits for all courses taken in that semester.

CGPA is similarly calculated considering all the courses taken from the time of admission.

17. Awarding Degree

After successful completion of the programme, the degree will be awarded with the following classifications based on CGPA.

For First Class with Distinction the student must earn a minimum of 65 credits within four semesters for full-time / six semesters for Part time from the time of admission, pass all the courses in the first attempt and obtain a CGPA of 8.25 or above.

For First Class, the student must earn a minimum of 65 credits within two years and six months for full-time / three years and six months for Part time from the time of admission and obtain a CGPA of 6.75 or above.

For Second class, the student must earn a minimum of 65 credits within four years for full-time / six years for Part time from the time of admission.

18. Ranking Of Candidates

The candidates who are eligible to get the M.E /M.Tech degree in First Class with Distinction will be ranked on the basis of CGPA for all the courses of study from I to IV semester for M.E / M.Tech full-time / I to VI semester for M.E / M.Tech part-time.

The candidates passing with First Class and without failing in any subject from the time of admission will be ranked next to those with distinction on the basis of CGPA for all the courses of study from I to IV semester for full-time / I to VI semester for M.E / M.Tech part-time.

19. Transitory Regulations

If a candidate studying under the old regulations M.E. / M.Tech could not attend any of the courses in his/her courses, shall be permitted to attend equal number of courses, under the new regulation and will be examined on those subjects. The choice of courses will be decided by the concerned Head of the department. However he/she will be permitted to submit the thesis as per the old regulations. The results of such candidates will be passed as per old regulations.

The University shall have powers to revise or change or amend the regulations, the scheme of examinations, the courses of study and the syllabi from time to time.

ANNEXURE -1

S.No.	Department		Programme (Full Time & Part time)	Eligible B.E./B.Tech Programme *
1	**Civil Engineering**	i.	Environmental Engineering	B.E. / B.Tech – Civil Engg, Civil & Structural Engg, Environmental Engg, Mechanical Engg, Industrial Engg, Chemical Engg, BioChemical Engg, Biotechnology, Industrial Biotechnology, Chemical and Environmental Engg.
		ii.	Environmental Engineering & Management	
		iii.	Water Resources Engineering & Management	B.E. / B.Tech – Civil Engg, Civil & Structural Engg, Environmental Engg, Mechanical Engg, Agricutural anf irrigation Engg, Geo informatics, Energy and Environmental Engg.
2	**Civil & Structural Engineering**	i.	Structural Engineering	B.E. / B.Tech – Civil Engg, Civil & Structural Engg.
		ii.	Construction Engg. and Management	
		iii.	Geotechnical Engineering	
		iv.	Disaster Management & Engg.	
3	**Mechanical Engineering**	i.	Thermal Power	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Mechanical Engg (Manufacturing).
		ii.	Energy Engineering & Management	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Mechanical (Manufacturing) Engg, Chemical Engg
4	**Manufacturing Engineering**	i.	Manufacturing Engineering	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Manufacturing Engg, Production Engg, Marine Materials science Engg, Metallurgy Engg, Mechatronics Engg, Industrial Engg.
		ii.	Welding Engineering	
		iii.	Nano Materials and Surface Engineering	B.E. / B.Tech – Mechanical Engg, Automobile Engg, Manufacturing Engg, Production Engg, Marine Materials science Engg, Metallurgy Engg, Chemical Engg
5	**Electrical Engineering**	i.	Embedded Systems	B.E. / B.Tech – Electrical and Electronics Engg, Control and Instrumentation Engg, Information technology, Electronics and communication Engg, Computer Science and Engg
		ii.	Smart Energy Systems	B.E. / B.Tech – Electrical and

		iii.	Power System	Electronics Engg, Control and Instrumentation Engg, Electronics and communication Engg,
6	**Electronics & Instrumentation Engineering**	i.	Process Control & Instrumentation	B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electornics Engg, Control and Instrumentation Engg, Instrumentation Engg
		ii.	Rehabilitative Instrumentation	B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electornics Engg, Electronics and communication Engg, Control and Instrumentation Engg, Instrumentation Engg, Bio Medical Engg, Mechatronics.
		iii.	Micro Electronics and MEMS	B.E. / B.Tech – B.E. / B.Tech – Electronics and Instrumentation Engg, Electrical and Electornics Engg, Electronics and communication Engg, Control and Instrumentation Engg, Instrumentation Engg, Bio Medical Engg, Mechatronics, Telecommunication Engg
7	**Chemical Engineering**	i.	Chemical Engineering	B.E. / B.Tech – Chemical Engg, Petroleum Engg, Petrochemical Technology
		ii.	Food Processing Technology	B.E. / B.Tech - Chemical Engg, Food Technology, Biotechnology, Biochemical Engg, Agricultural Engg.
		iii.	Industrial Bio Technology	B.E. / B.Tech - Chemical Engg, Food Technology, Biotechnology, Leather Technology
		iv.	Industrial Safety Engineering	B.E. / B.Tech – Any Branch of Engineering
8	**Computer Science & Engineering**	i.	Computer Science & Engineering	B.E. / B.Tech - Computer Science and Engineering, Information Technology, Electronics and Communication Engg, Software Engineering
9	**Information Technology**	i	Information Technology	B.E. / B.Tech - Computer Science and Engineering, Information Technology, Electronics and Communication Engg, Software Engineering
10	**Electronics & Communication Engineering**	i.	Communication Systems	B.E. / B.Tech - Electronics and Communication Engg, Electronics Engg.

*** AMIE in the relevant discipline is considered equivalent to B.E**

DEPARTMENT OF MECHANICAL ENGINEERING

Curriculum for M.E. Thermal Power Engineering (Full Time)

FIRST SEMESTER

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits
1	PC-I	TPEC101	Advanced Numerical Methods	4		-	25	75	100	3
2	PC-II	TPEC102	Advanced Thermodynamics	4		-	25	75	100	3
3	PC-III	TPEC103	Advanced Fluid Mechanics	4		-	25	75	100	3
4	PC-IV	TPEC104	Advanced Heat Transfer	4		-	25	75	100	3
5	PE-I	TPEE105	Professional Elective - I	4		-	25	75	100	3
6	PE-II	TPEE106	Professional Elective – II	4		-	25	75	100	3
7	PC Lab-I	TPEP107	Thermal Laboratory - I	-	3	-	40	60	100	2
			Total	**24**	**3**	**-**	**190**	**510**	**700**	**20**

SECOND SEMESTER

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits
1	PC-V	TPEC201	Advanced Refrigeration and Air conditioning Systems	4	-	-	25	75	100	3
2	PC-VI	TPEC202	Design of Thermal Power Equipments	4	-	-	25	75	100	3
3	PC-VII	TPEC203	Advanced Power Plant Engineering	4	-	-	25	75	100	3
4	PC-VIII	TPEC204	Instrumentation in Thermal Engineering	4	-	-	25	75	100	3
5	PE-III	TPEE205	Professional Elective – III	4	-	-	25	75	100	3
6	PE-IV	TPEE206	Professional Elective – IV	4	-	-	25	75	100	3
7	PC Lab-II	TPEP207	Thermal Laboratory - II	-	3	-	40	60	100	2
8	Semin	TPES208	Seminar		2	-	100	-	100	1
			Total	**24**	**5**	**-**	**290**	**510**	**800**	**21**

THIRD SEMESTER

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits
1	OE-I	TPEE301	Open Elective- I	4	-	-	25	75	100	3
2	OE-II	TPEE302	Open Elective -II	4	-	-	25	75	100	3
3	Thesis	TPET303	Thesis Phase- I and Viva Voce	-	-	4	40	60	100	4
4	Ind. Train	TPEI304	Industrial Training			*	100	-	100	2
			Total	**8**	**-**	**4**	**190**	**210**	**400**	**12**

Note: * - Four weeks during the summer vacation at the end of IInd Semester.

FOURTH SEMESTER

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits
1	Thesis	TPET401	Thesis Phase - II and Viva Voce	-	-	8	40	60	100	12
			Total	**-**	**-**	**8**	**40**	**60**	**100**	**12**

L- Lecture ; **P-** Practical; **T-** Thesis; **CA-** Continuous Assessment; **FE-** Final Examination

DEPARTMENT OF MECHANICAL ENGINEERING

Curriculum for M.E. Thermal Power Engineering (Part Time)

First Semester

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Code
1	PC-I	PTPEC101	Applied Mathematics	4		-	25	75	100	3	TPEC101
2	PC-II	PTPEC102	Advanced Thermodynamics	4		-	25	75	100	3	TPEC102
3	PC-III	PTPEC103	Advanced Fluid Mechanics	4		-	25	75	100	3	TPEC103
			Total	**12**			**75**	**225**	**300**	**9**	

Second Semester

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Code
1	PC-IV	PTPEC201	Advanced Heat Transfer	4		-	25	75	100	3	TPEC104
2	PC-V	PTPEC202	Advanced Refrigeration & Air conditioning Systems	4		-	25	75	100	3	TPEC201
3	PC-VI	PTPEC203	Design of Thermal Power Equipments	4		-	25	75	100	3	TPEC202
			Total	**12**			**75**	**225**	**300**	**9**	

Third Semester

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Code
	PC-VII	PTPEC301	Advanced Power Plant Engineering	4		-	25	75	100	3	TPEC203
	PE-I	PTPEE302	Professional Elective - I	4		-	25	75	100	3	TPEE104
	PE-II	PTPEE303	Professional Elective – II	4		-	25	75	100	3	TPEE105
	PC Lab-I	PTPEP304	Thermal Laboratory - I		3	-	40	60	100	2	TPEP107
			Total	12	3	**-**	**115**	**285**	**400**	**11**	

Fourth Semester

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Code
1	PC-VIII	PTPEC401	Instrumentation in Thermal Engineering	4		-	25	75	100	3	TPEC204
2	PE-III	PTPEE402	Professional Elective-III	4		-	25	75	100	3	TPEE205
3	PE-IV	PTPEE403	Professional Elective-IV	4		-	25	75	100	3	TPEE206
4	PCLab-II	PTPEP404	Thermal Laboratory-II		3	-	40	60	100	2	TPEP207
			Total	12	3	**-**	**115**	**285**	**400**	**11**	

Fifth Semester

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Code
1	OE-I	PTPEE 501	Open Elective I	4	-	-	25	75	100	3	TPEE301
2	OE-II	PTPEE 502	Open Elective II	4	-	-	25	75	100	3	TPEE302
3	Thesis	PTPET 503	Thesis Phase I and Viva Voce		-	4	40	60	100	6	TPET303
4	Ind. Train	PTPEI304	Industrial Training			*	100	-	100	2	TPEI304
			Total	8	**-**	**4**	**90**	**210**	**300**	**12**	

Note: * - Four weeks during the summer vacation at the end of IVth Semester.

Sixth Semester

Sl. No.	Category	Course Code	Course	L	P	T	CA	FE	Total	Credits	Equivalent Code
1	Thesis	PTPET601	Thesis Phase II and Viva Voce	-	-	8	40	60	100	13	TPET401
			Total	**-**	**-**	**8**	**40**	**60**	**100**	**13**	

L- Lecture ; **P-** Practical; **T-** Thesis; **CA-** Continuous Assessment; **FE-** Final Examination

LIST OF ELECTIVES

PROFESSIONAL ELECTIVES

1. Analysis and Design of Turbo Machines
2. Mechanical Design of Rotodynamic Machines
3. Design of Heat Exchangers
4. Fluidized Bed Systems
5. Bio Energy Conversion Technologies
6. Cogeneration and Waste Heat Recovery Systems
7. Computational Heat Transfer
8. Computational Fluid Dynamics
9. Advanced Engines and Emission Systems
10. Finite Element Methods In Thermal Engineering
11. Thermal System Analysis
12. Energy Conservation in HVAC Systems
13. IC Engine Combustion and Measurement Techniques
14. Power Plant Management
15. Process Instrumentation
16. Nuclear Engineering
17. Alternate Fuels for Internal Combustion Engine

OPEN ELECTIVES

1. Numerical Analysis
2. Microprocessor and Applications
3. Waste Management and Energy Generation Techniques
4. Power Plant Instrumentation and Controls
5. Mechanical Behavior of Materials
6. Metal Joining Technology
7. Optimization Techniques
8. Impact Engineering
9. Composite Materials

TPEC101	ADVANCED NUMERICAL METHODS	L	T	P
		4	0	0

COURSE OBJECTIVES

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

Algebraic Equations

Systems of linear equations: Gauss Elimination method, pivoting techniques, Thomas algorithm for tridiagonal system – Jacobi, Gauss Seidel, SOR iteration methods - Systems of nonlinear equations: Fixed point iterations, Newton Method, Eigenvalue problems: power method, inverse power method, Faddeev – Leverrier Method.

Ordinary Differential Equations

Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

Finite Difference Method for Time Dependent Partial Differential Equation

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines – Wave equation: Explicit scheme- Stability of above schemes.

Finite Difference Methods for Elliptic Equations

Laplace and Poisson's equations in a rectangular region: Five point finite difference schemes, Leibmann's iterative methods, Dirichlet and Neumann conditions – Laplace equation in polar coordinates: finite difference schemes – approximation of derivatives near a curved boundary while using a square mesh.

Finite Element Method

Partial differential equations – Finite element method - orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method.

REFERENCES

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2. Gupta S.K., "Numerical Methods for Engineers", New Age Publishers, 1995
3. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", Cengage Learning, India Edition, New Delhi, 2009.

4. Jain M. K., Iyengar S. R., Kanchi M. B., Jain , "Computational Methods for Partial Differential Equations", New Age Publishers,1993.
5. Morton K.W. and Mayers D.F., "Numerical solution of partial differential equations", Cambridge University press, Cambridge, 2002.

COURSE OUTCOMES

Upon completion of this course, the students will be able to

1. Solve engineering problems numerically.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓	✓		✓				

TPEC102	**ADVANCED THERMODYNAMICS**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES

- To achieve an understanding of basic principle and scope of thermodynamics.
- To predict the availability and irreversibility associated with the thermodynamic processes.
- To analyse the properties of ideal and real gas mixtures. Also to achieve an understanding of Statistical thermodynamics and Irreversible thermodynamics.

Availability Analysis and Thermodynamic Property Relations

Reversible work, Availability, Irreversibility and Second-Law Efficiency for a closed System and Steady-State Control Volume. Availability Analysis of Simple Cycles. Thermodynamic Potentials, Maxwell relations, Clausius Clayperon Equation, Joule-Thomson Coefficient, Bridgman Tables for Thermodynamic relations.

Real Gas Behaviour and Multi-Component Systems

Different Equations of State, Fugacity, Compressibility, Principle of Corresponding States, Use of generalised charts for enthalpy and entropy departure, fugacity coefficient, Lee-Kesler generalized three parameter tables.

Fundamental property relations for systems of variable composition, partial molar properties, Real gas mixtures, Ideal solution of real gases and liquids, Activity, Equilibrium in multi phase systems, Gibbs phase rule for non-reactive components.

Statistical Thermodynamics

Microstates and Macrostates, Thermodynamic probability, Degeneracy of energy levels, Microscopic Interpretation of heat and work, Evaluation of entropy, Partition function, Calculation of the Macroscopic properties from partition functions, Equilibrium constant statistical thermodynamics approach.

Irreversible Thermodynamics

Conjugate Fluxes and Forces, Entropy Production Onsager's Reciprocity relations, Thermo-electric phenomena.

REFERENCES

1. Kenneth Wark Jr., Advanced Thermodynamics for Engineers, McGraw-Hill Inc.,1995.
2. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Sons, 1988.
3. Holman,J.P., Thermodynamics, Fourth Edition, McGraw-Hill Inc., 1988.
4. Smith, J.M. and Van Ness., H.C., Introduction to Chemical Engineering Thermodynamics, Fourth Edition, McGraw-Hill Inc., 1987.
5. Sonntag, R.E., and Van Wylen, G, Introduction to Thermodynamics, Classical and Statistical, Third Edition, John Wiley and Sons, 1991.
6. Sears, F.W. and Salinger G.I., Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Third Edition, Narosa Publishing House, New Delhi, 1993.
7. DeHotf, R.T., Thermodynamics in Materials Science, McGraw- Hill Inc., 1993.

COURSE OUTCOMES:

On successful completion of this course the student will be able to

1. Apply the law of thermodynamics to thermal systems.
2. Calculate the availability of the systems and cycles
3. Analyse the engineering systems to improve and optimize its performance

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓								
CO2	✓	✓								
CO3	✓	✓	✓	✓					✓	✓

TPEC103	ADVANCED FLUID MECHANICS	L	T	P
		4	0	0

COURSE OBJECTIVES

- Learn and Understand the Concepts of fluid flow problems
- Acquiring the computational Knowledge in Fluid flow models
- Application of differential equations in fluids applications

Fundamentals of fluid flow

Isentropic flow, Compressible flow, adiabatic Flow, Flow in constant area ducts – with friction - with out friction – problems. Fanno line-Rayleigh's line. CFD Models of flow, continuity, momentum and energy equations, Navier- Stokes equation, Euler equation, physical boundary conditions-Applications

Physical significance of irrotational motion

Kelvins theorem- Connection between the rotation and the thermodynamic properties of flow - Crocco's theorem – Equation of continuity (3d).

Differentials equations in terms of Velocity potential and Stream function

Relation between stream function and velocity potential.

Two dimensional Subsonic flow

Flow with small perturbations, Flow past a wave shaped wall –Gothert's rule-Laitone's modification of PrandtlGlauret rule – affine transformations – Hodograph method –Tangent Gas approximations – Rayleigh Johnson method.

Two dimensional supersonic flow

Reflection and intersection of Waves –Simple Waves –Centered Waves – Flow past a Wave shaped wall – Prandtl Meyer form –flow with waves of both families. Simple supersonic Wind tunnel – Design of supersonic wind tunnel Nozzle–Flow with normal shock waves -Prandtl Meyer relation - problems.

REFERENCES

1. Computational Fluid Dynamics, J.D.Anderson, Jr., Mc.Graw Hill, International Edition, 1995
2. Turbines Compressors and Fans – S.M.Yahya, Tata McGraw Hill, New Delhi, 1998
3. Dynamics and Thermodynamics of Compressible fluid flow, Vol. I & II – A.H.Shapiro, Ronald Press Company, New York, 1964.
4. Fundamentals of Compressible flow – S.M.Yahya, New Age Publishers, New Delhi, 1992.
5. Fluid Dynamics – Streeter, McGraw Hill , New York, 1972.
6. Gas Dynamics – E. Radha Krishnan, Prentice Hall, New Delhi, 2002.
7. Advanced Fluid Mechanics – R.C.Binder , Prentice Hall, New Delhi, 1972.

COURSE OUTCOMES

1. Concepts of fluid flow problems will make the engineering graduate to apply the knowledge in real time applications.
2. Graduate may become an researcher, entrepreneur or an employer in fluid flow industry
3. Development of software Fluid models incorporating the mathematical knowledge for real time applications

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓		✓		✓	✓	✓		
CO2			✓		✓					
CO3			✓	✓	✓		✓			

TPEC104	**ADVANCED HEAT TRANSFER**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES

- To develop the ability to use the heat transfer concepts for various applications like finned systems, turbulence flows, high speed flows.
- To develop the numerical approach to solve the heat transfer problem
- To carry out the thermal analysis and design of heat exchangers .

Review on mechanism of heat and mass transfer – balance laws and constitutive equations.

Conduction

Review of general heat conduction equations – 1-D heat conduction with variable heat generation – boundary and initial conditions – heat transfer from extended surfaces – use of transient temperature charts – lumped system analysis – periodic heat flow. Numerical heat transfer: Finite difference formulation of steady and transient heat conduction problems – solution procedures (Gaussian elimination and iterative procedures).

Convection

Review on the concept of boundary layer – N-S equations – Momentum and energy integral equations (Flat plate – fully developed tube flow). Turbulent heat transfer – introduction to turbulence model (k-ε model) – mixing length concept – Analogy between heat and momentum transfer (Reynolds, Colburn, Von-Karman analogy – Turbulent flow in a tube. Porous media heat transfer : Basic principles of flow and heat transfer.

Radiation

Review of radiation shape factor – thermal shields – concept of radiosity method – radiation by gases and flames.

Two phase flows and boiling and condensation heat transfer

Fundamentals of 2-phase flows: Homogenous, separated and drift flux models – Two phase flow pressure drop.

Heat Exchange Equipments

Review of LMTD - ε - NTU approach – Compact exchangers, packed and fluidized systems. Special topics of heat transfer: (Qualitative treatment only) Ablative cooling – Cooling of electronic components – Heat transfer analysis in I.C. engines – High speed flows – Heat pipes.

REFERENCES

1. Incropera F.P. and DeWitt.D.P., Fundamentals of Heat & Mass Transfer, John Wiley & Sons, 1996.
2. Nag P.K., Heat transfer , Tata McGraw-Hill , 2002.
3. Ozisik.M.N., Heat Transfer - Basic Approach, McGraw-Hill Co., 1985.
4. Bejan.A., Convection Heat Transfer, John Wiley and Sons, 1984.
5. McAdams W.H., Heat transmission, McGraw-Hill Book Co., 1958
6. Wallis G.B., One-Dimensional two phase flow, McGraw-Hill Book Co., 1969.
7. Bird R.B., Stewart W.E. and Lightfoot E.N., Transport Phenomena, John Wiley & Sons, 1994.

COURSE OUTCOMES

1. On successful completion of this course the student will be able to apply the law of thermodynamics and heat transfer to real life heat transfer problems.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓	✓					✓	

TPEP107	THERMAL LABORATORY - I	L	T	P
		0	0	3

COURSE OBJECTIVES

- To conduct the load test, speed test and Heat Balance Test of a single and double cylinder diesel engine
- To evaluate the performance of steam boiler, turbine and condenser.
- To make the students understand the working principle of various types of governors, balancing systems, Cam analyzer, Torsional vibration of single rotor system, whirling speed concept, action of forces in gyroscope.

List of Experiments

1. Study and Performance test on Kaeser air compressor test rig.
2. Heat balance test and air fuel determination on a Diesel Engine
3. Effect of injection pressure on the performance and emission of Diesel Engine.
4. Determination of Damping coefficient in damping torsional oscillation.
5. Experimentation of pressure processes station by PID control.
6. Demonstrate the gyroscopic effects and determination of gyroscopic couple.
7. Performance evaluation of loco type boiler.
8. Performance evaluation of greenbat turbine with condenser.
9. Performance evaluation of reader vertical steam engine.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Gain knowledge about the combustion principles.
2. Analyze the performance of steam boiler, turbine and condenser.
3. Supplement the principles learnt in kinematics and Dynamics of Machinery.

Mapping with Programme Outcomes										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	✓	✓	✓				✓			
CO2	✓	✓					✓			✓
CO3	✓	✓					✓		✓	✓

TPEC201	ADVANCED REFRIGERATION AND AIR CONDITIONING SYSTEMS	L	T	P
		4	0	0

COURSE OBJECTIVES

- To understand the principle of operation and design aspects of refrigeration and air conditioning system and its components with multistage.
- To learn the selection procedure and design of duct system with pipe lines
- To learn the concept of cooling load calculation and comfort design of air conditioning systems

Refrigeration cycles - representation on T-s and p-H charts - comparison of refrigerants, their properties and advantages-Refrigerant piping and Design-Mixed refrigerants Problems of refrigerating cycles, multistage cycles. Cascade system –Vapour absorption system.

Thermal design of compressor, condenser, evaporator and expansion devices - selection of condensers and evaporators-design of pipe lines-selection and matching of components.

Review of psychrometric processes - Cooling load calculations, selection of standard comfort design of air-conditioning system. Critical loading conditions, selection of cooling unit, air cleaning systems and air filters.

Passive heating and cooling of Building, Selection of duct arrangements, duct layout, duct design, duct installation - duct maintenance- sheet metal standards- duct materials – pressure balancing of ducts, duct sizing- Friction and dynamic losses in duct, static regain method-problems.

Lubricants, driers, dehydrators, desiccant-Evacuation and charging of refrigerators and air conditioners-Leak detection and troubleshooting-matching of thermostatic expansion valve-Automatic expansion valve (Constant Pressure) Design of capillary tube for refrigerators-Procedure for long shut-down - descaling of condenser.

REFERENCES

1. Stoecker - Refrigeration and Air-conditioning, Tata McGraw Hill, New Delhi, 1985.
2. V.K.Jain - Refrigeration and Air-conditioning - S. Chand & Co, New Delhi,
3. Jordan and Priester - Refrigeration and Air-conditioning, Prentice Hall, New Delhi, 1968.
4. ASHRAE Hand book, Fundamentals & Equipments, 1962.
5. Jennings & Lewis – Air conditioning and Refrigeration, John Wiley & Sons, 1967.
6. Manohar Prasad - Refrigeration and Air conditioning data book- Wiley Eastern., 1985.
7. Dossat - Principles of Refrigeration, Wiley Eastern Ltd., New Delhi, 1983.

COURSE OUTCOMES

Upon completion of this course the students will be able to,

1. Appreciate the principle of operation of multistage and different refrigeration and air conditioning system
2. Understand the design and selection procedure of air conditioning components with its thermal behaviors

3. Learn the design of duct system, charging of refrigeration, trouble shooting procedure and its applications in air conditioning system

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓								
CO2	✓	✓								
CO3			✓		✓			✓	✓	✓

TPEC202	**DESIGN OF THERMAL POWER EQUIPMENTS**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES

The course should enable the students to

- Provide knowledge of various components and its types used in thermal power plants.
- Provide knowledge of design principles of various components in thermal power plants.
- Understand the limitations, advantages and disadvantages of various components.

Design considerations

Service requirements – Parameters to be considered in boiler design. Furnace design: heat transfer in furnaces – furnace heat balance – design of furnaces. Water wall design: Circulation – Positive and natural circulation – circulation ratio.

Condenser Design

Types of condensers – Design of condensers – Surface area calculation – Air leakage and its effects – methods of removal of air leakage – Condenser water cooling system – Air pump – Wet and Dry capacity and dimensions.

Super heater Design

Types of super heaters – Location – Performance – Radiation and convection characteristics – Design of super heater – Super heater temperature control.

Evaporator Design

Types of evaporators – Details of submerged types evaporator – Single effect and double effect evaporator – Steam requirements. Steam Purification: Mechanical carry over – Silica carry over – gravity separate – Typical separate economizer arrangement – Design of an economizer suitable for a power plant.

Air Heaters

Advantages – Disadvantages – Recuperative and Regenerative Air pre-heaters – Design considerations – High temperature and low temperature limitations.Draft System Design: Power required for draught fan, Pressure losses, diameter and height of the Chimney – Chimney design.

REFERENCES

1. Arora S.C. and Domkundwar S., Power Plant Engineering, Dhanpat Rai & Co., New Delhi, 1996.
2. Vopat and Skrotzki, Power Plant Engineering, Tata McGraw Hill Book Co., New Delhi, 1972.
3. Oliver Lyle, The efficient use of Steam, Her Majesty's Stationery Office, London, 1962.
4. Potter, Power Plant Theory and Design, The Ronald Press Co., New York, 1962.
5. Potter, Steam Power Plant, The Ronald Press Co., New York, 1961.
6. Gaffart, Steam Power Stations, McGraw Hill Book Co., New York, 1960.

COURSE OUTCOMES

Upon completion of the course the students will be able to
1. Design a system or components required to meet desired needs.
2. Select the capacity of various components based on design requirements.
3. Work effectively as team members in thermal power plant projects.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**P09**	**P10**
CO1	✓									
CO2		✓			✓					
CO3									✓	✓

TPEC203	ADVANCED POWER PLANT ENGINEERING	L	T	P
		4	0	0

COURSE OBJECTIVES

- To understand and analyze the present and future energy demand of world and nation and techniques to exploit the available renewable energy resources such as, solar, bio-fuels, wind power, tidal and geothermal effectively

Direct Energy Conversion

Principles and operation of MHD – Design length of channel – Hall effect – Types of MHD generators – Applications of MHD – Principles of EHD and operation – Fuel cells – Principles of Hydrogen – Oxygen fuel cell – Hydro-carbon fuel cells – Redox fuel cell – Lithium Hydrogen fuel cells.

Power Plants

Design of coal bunkers – Co-generation – combined gas and steam power plants – Advantages of Combined cycles – Binary Vapour cycles.

Solar Energy

Storage – Stratified storage – Well mixed storage – Comparison – Solar ponds – types – Description of Non-Convective solar pond – Extraction of Thermal energy – Application of solar pond. Solar Electric Power Generation – Tower concept – Photovoltaic cells – Design of swimming pool heaters & Power generation systems – Utilisation of bio-mass – Combustion – Pyrolysis- Gasification – Design of Gasifier – Heat and power generation applying bio-mass.

Other Non-Conventional Energy Systems

Geo-thermal energy – Different types of geothermal energy systems – Economic justification – OTEC power plants – Types & working principle.

Tidal Power Plants

Types – Working principle – Advantages & Disadvantages – Bio-gas generation and uses. Wind energy – Different types of wind power plants – problems on wind turbines – Advantages and disadvantages.

REFERENCES

1. Soo S.L., Direct Energy Conversion, 1965.
2. Rai G.D., Solar Energy Utilisation, Khanna Publishers, New Delhi, 1998.
3. Suhatme S.P., Solar Energy – Principles of Thermal Collection & Storage, Tata McGraw Hill
4. Elwakil M, Power Plant Technology, McGraw Hill, New York, 1964.
5. Archie W. Culp. Jr., Principles of Energy Conversion, McGraw Hill, 1968.
6. Kreider J.M. and Krieth J.F., Principles of Solar Engineering, McGraw Hill, New York, 1972.
7. Peter J.Lunde, Solar Thermal Engineering, John Wiley & Sons, New York, 1978.

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

1. Acquire fundamental knowledge in energy generation, heat transfer and to utilisation-renewable energy-conversion technology
2. Ability to use modern engineering tools, software and equipment to analyze and solve complex engineering problems.
3. Solve real world problems and reduce the impact global warming for betterment of living things to serve healthy life.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓					✓		
CO2			✓			✓	✓			
CO3	✓			✓					✓	✓

		L	T	P
TPEC204	**INSTRUMENTATION IN THERMAL ENGINEERING**	**4**	**0**	**0**

COURSE OBJECTIVES

- To understand the working principles of various instruments used in thermal power plants
- To acquire the knowledge of working of modern equipment.

Concept of Generalized Measurement System

System configurations - Errors Problem analyses - Basic characteristics of measuring devices – Calibration – introduction to data acquisition and processing systems – compact data loggers.

Temperature

Thermo electric sensors – Thermocouple & electrical resistance- Radiation & optical thermometers – Quartz crystal Thermometers – High speed Temperature probe.

Gas analysis

Measurement of CO_2, NO_2,CO, hydrocarbon and SO_2 – use of chromatography – smoke Measurement. NO_X and particulate measurement – Concentration measurement.

Pressure

Variable reluctance & LVDT Type pressure sensors – Knudsen gauge – Thermal conductivity ionization gauge High pressure measurement – Piezo-electric and vibrating elements pressure sensors.

Flow

Electromagnetic flow meter–Smoke tube and laser Doppler anemometer - ultrasonic flow meter–Rotor Torque mass flow meter–Flow visualization Techniques–shadow graph–Schilierene Apparatus. Measurement of speed, vibration, humidity, heat flux and time.

REFERENCES

1. J.P.Holman – Experimental Methods for Engineers- McGraw Hill, New York, 1988.
2. C.S.Rangan ,G.R.Sharma ,V.S.V.Mani - Instrumentation Devices and systems ,Tata Mcgraw Hill, New Delhi,1983.
3. Ernest O. Doebelin - Measurement Systems -Application and Design, McGraw – Hill, New York, 1990.
4.

COURSE OUTCOMES

Upon completion of this course, the students will be able to:
1. Understand the advances in the field of instrumentation.
2. Learn the various instrumentation terminologies in thermal engineering.
3. Acquire the principle and working of modern equipments.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**
CO1	✓			✓						
CO2			✓			✓				✓
CO3	✓					✓				✓

TPEP207	THERMAL LABORATORY - II	L	T	P
		0	0	3

COURSE OBJECTIVES

- To make the students understand the modes of heat transfer and to conduct the trails on various experiments to analyze the heat transfer parameters.
- To understand the working of refrigeration trainer and air conditioners.
- To study the basics of solar energy.

List of Experiments

1. Natural convection from vertical cylinder
2. Experiments on finned tube heat exchanger
3. Experiments on unsteady state heat transfer apparatus.
4. Determination of thermal conductivity of metal rod.
5. Experiments on composite wall apparatus
6. Performance test on central A/C plant
7. Performance test on vapor absorption refrigeration system
8. Performance test on Solar still
9. Performance test on Solar concentrator test rig.
10. Performance test on Solar cooker.

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the behavior of a system at different operating conditions
2. Understand the usage of different refrigeration tools.
3. Learn the basics of solar energy, how to determine solar intensity, and how to estimate daily and annual solar energy potential at each location

Mapping with Programme Outcomes										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	✓	✓					✓			
CO2	✓					✓	✓			✓
CO3	✓	✓					✓		✓	✓

TPET303	THESIS PHASE I AND VIVA VOCE	L	T	P
		0	4	0

COURSE OBJECTIVES

- To enhance the research and development activities of the students.

COURSE OUTCOMES

1. The students' would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to be creative, well planned, organized, coordinated in their project work phase–II.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓	✓	✓		✓		✓	✓	✓

TPEI304	INDUSTRIAL TRAINING	L	T	P
		0	*	0

COURSE OBJECTIVES:

- To train the students in the field work related the Mechanical Engineering and to have a practical knowledge in carrying out Structural field related works.
- To train and develop skills in solving problems during execution of certain works related to Manufacturing Engineering.

The students individually undergo a training program in reputed concerns in the field of Manufacturing Engineering during the summer vacation (at the end of second semester for full – time / fourth semester for part – time) for a minimum stipulated period of four weeks. At the end of the training, the student has to submit a detailed report on the training he had, within ten days from the commencement of the third semester for Full-time / fifth semester for part-time. The students will be evaluated by a team of staff members nominated by head of the department through a viva-voce examination.

COURSE OUTCOMES:

1. The students can face the challenges in the practice with confidence.
2. The student will be benefited by the training with managing the situation arises during the execution of works related to Manufacturing Engineering.

Mapping of Course Outcomes with Programme Outcomes					
COs/POs	PO1	PO2	PO3	PO4	PO5
CO1			✓	✓	
CO2				✓	✓

FOURTH SEMESTER

TPET401	THESIS PHASE II AND VIVA VOCE	L	T	P
		0	8	0

COURSE OBJECTIVES

- To improve the student research and development activities.
- To improve presentation and report preparation skills.

COURSE OUTCOMES

1. The students would apply the knowledge in solving problems, so as to give confidence to be creative, well planned, organized, coordinated project outcome of the aimed work.

Mapping with Programme Outcomes										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	✓	✓	✓	✓		✓		✓	✓	✓

PROFESSIONAL ELECTIVE SUBJECTS

TPEEX0X	ANALYSIS AND DESIGN OF TURBO MACHINES	L	T	P
		4	0	0

COURSE OBJECTIVES

- To equip the students with necessary foundation for effective analyzing and solving the problem.
- To enlighten the thermodynamics aspects of energy transfer.
- To study the flow characteristics of Turbo machines.

Theory of Turbo machines

Introduction – Classification of Turbo machinery – Energy transfer between a fluid and a Rotor – Euler Turbine equation – Components of energy transfer – Internal and external losses – Efficiencies. Impulse and Reaction turbine – degree of reaction –Utilisation factor – Speed ratio.

Flow of fluid through rotor blades – One and two dimensional incompressible flow analysis – Calculation of velocity and pressure – Radial pressure gradient – Free vortex flow – Forced vortex flow (Theory only). Two dimensional cascades – Experimental study – Correlations, Ainley, Soderberg, and Howell's (Theory only).

Fans, Blowers and Pumps

Radial and axial flow – single and multistage flow through impeller – Design parameters- Selection of empirical and experimental data for design – Performance characteristics – Stability of operation.

Dimensional Analysis and Similarity law – Applied to Incompressible flow machine – Head capacity, Power Coefficient – Reynolds Number and Mach Number – Specific Speed – Compressible flow machine – Pressure ratio – Dimensionless speed and mass – flow parameter – Power Coefficient – Reynolds Number – Performance Characteristic curves of Turbine, Compressor, Fan, Blower and cascade (with some Dimensionless Parameter).

Steam Turbines

Types – Design of impulse and Reaction stages – 50 percent reaction steam turbine – Blade and nozzle losses – efficiencies – Reheat factor.

REFERENCES

1. Dr. Yahya S.M., Turbomachines, Tata McGraw Hill, New Delhi, 1998.
2. Shepherd D.G., Principles of Turbomachines, Macmillan, London, 1968.
3. Dr. Yahya S.M., Turbines, Compressors and Fans, Tata McGraw-Hill, New Delhi, 1998.
4. Keartow W.O., Steam Turbine theory and practice, ELBS, London, 1995.
5. Jagdishlal and Church A.M., Centrifugal pumps and blowers, Metropolitan Book Company, 1988.

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Gain the knowledge for all forms of turbo machines.
2. Study the fluid flow analysis through turbine blades.
3. Analyze design characteristics of fan, blower and pumps.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓							✓	
CO2	✓	✓				✓	✓		✓	
CO3			✓	✓		✓				

TPEEX0X	MECHANICAL DESIGN OF ROTODYNAMIC MACHINES	L	T	P
		4	0	0

COURSE OBJECTIVES

- Knowledge of Rotodynamic machine and to perform design, operation, performance evaluation and research in the area.
- To educate the students with knowledge of experimental techniques and instruments required.
- To impart knowledge on conceptual design of different components of thermal and hydro turbo machines.

Introduction to Mechanical Design Aspects

Stresses in Rotating discs – Uniform thickness – varying thickness – Determination of elastic stresses – Loosening speed – shrinkage allowance – Interference fit between rotor and shaft.

Bearings

Different design considerations – Hydrodynamic Journal bearings – Hydro-static bearings – Sealing devices.

Eigen Value Problems

Torsional, Longitudinal and lateral vibration problems.

Jacobi Givens and Householder’s transformations – Forward and inverse iteration schemes – Gram Schmidt deflation technique to find the natural frequencies – Simultaneous iteration method – Standard eigen value form – non-standard eigen value form – Subspace iteration – Lanczo’s method.

Industrial applications – Determination of critical speeds – including gyroscopic effect – eigen pairs of boiler frame – Eigen values of compressor disc.

REFERENCES

1. Dr. Ramamurti V., Computer Aided design in Mechanical Engineering, Tata McGraw-Hill Pub. Co., 1987.
2. Den Hertog, Advanced Strength of Materials, MacMillan & Co., 1983.
3. Tse, Morse and Hinkle, Mechanical Vibrations, Prentice Hall of India Pvt. Ltd., 1995.
4. Yahya, S.H., Turbines, Compressor and Fans, Tata McGraw Hill Publishing Company, 1996.

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Equip fundamental knowledge on principle of operation, component details and performance evaluation.
2. Carryout research and development in the area of rotodynamic machines.
3. Comprehend concepts and develop academic skills to disseminate knowledge to others.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓			✓			✓	
CO2	✓	✓						✓		
CO3		✓	✓	✓		✓				

TPEEX0X	**DESIGN OF HEAT EXCHANGERS**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES

- To expose the student to perform the energy transfer analysis on the all types of heat exchangers.
- To impart the knowledge about phase changes-Special application to Condensers and Evaporators.
- To understand and solve the real life industrial problems for heat exchanger design and optimization.

Constructional Details and Heat Transfer

Types - Shell and Tube Heat Exchangers - Regenerators and Recuperators - Industrial Applications Temperature Distribution and its Implications - LMTD - Effectiveness

Flow Distribution and Stress Analysis

Effect of Turbulence - Friction Factor - Pressure Loss - Channel Divergence Stresses in Tubes - Heater Sheets and Pressure Vessels - Thermal Stresses - Shear Stresses - Types of Failures

Design Aspects

Heat Transfer and Pressure Loss - Flow Configuration - Effect of Baffles - Effect of Deviations from Ideality - Design of Typical Liquid - Gas-Gas-Liquid Heat Exchangers

Condensers and Evaporators Design

Design of Surface and Evaporative Condensors - Design of Shell and Tube - Plate Type Evaporators

Cooling Towers

Packings - Spray Design - Selection of Pumps - Fans and Pipes - Testing and Maintenance - Experimental Methods

REFERENCES

1. T. Taborek, G.F. Hewitt and N.Afgan, Heat Exchangers, Theory and Practice, McGraw Hill Book Co., 1980.
2. Walker, Industrial Heat Exchangers - A Basic Guide, McGraw Hill Book Co., 1980.
3. Nicholas Cheremisioff, Cooling Tower, Ann Arbor Science Pub 1981.
4. Arthur P.Fraas, Heat Exchanger Design, John Wiley & Sons, 1988
5. Donald Q Kern, Process Heat Transfer, Tata McGraw Hill, 2008.

WEBSITES

1. http ://www.thermomax.com
2. http ://www.tata.com
3. http ://www.altalevel.com

COURSE OUTCOMES

Upon completion of the course, students will be able to

1. Perform the energy transfer in the all types of heat exchangers.
2. Perform heat exchanger design using engineering equation solver.
3. Perform energy transfer analysis for research and develop energy effective systems.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓						✓			
CO2				✓		✓				
CO3			✓		✓			✓		

TPEEX0X	FLUIDIZED BED SYSTEMS	L	T	P
		4	0	0

COURSE OBJECTIVES

- To understand the design principles and applications of fluidized bed systems.
- To introduce the concepts of fluidization and heat transfer in fluidized beds.

Fluidized Bed Behaviour

Fluidization Phenomena - Regimes of Fluidized Bed Behaviour - Characterization of Fluidized Particles - Two Phase and Well Mixed Theory of Fluidization - Solids Mixing - Particle Entrainment and Carryover.

Heat Transfer

Different Modes of Heat Transfer in Fluidized Bed - Use of Immersed Tubes - Finned Tubes - Heat Recovery Systems.

Combustion and Gasification

Fluidized Bed Combustion and Gasification, Pressurised Systems, Sizing of Combustion and Gasification Systems, Start-up Methods, Fast Fluidized Beds, Different Modes of Heat Transfer in Fluidized Beds.

System Design

Design of Distributors, Fluidized Bed Furnaces for Fossil and Agricultural Fuels, Fluidized Bed Heat Recovery Systems, Fluid Bed Dryers.

Industrial Applications

Sulphur Retention - Nitrogen Emission Control - Furnaces, Dryers, Heat Treatment, etc. Pollution Control and Environmental Effects - Cost Analysis

REFERENCES

1. Howard, J.R., Fluidized Bed Technology: Principles and Applications, Adam Hilger, New York, 1983.
2. Geldart, D, Gas Fluidization Technology, John Wiley & Sons, New York, 1986.
3. Howard, J.R. (Ed), Fluidized Beds : Combustion and Applications, Applied Science Publishers, New York 1983.
4. Yates, J.G. Fundamentals of Fluidized bed Chemical Processes, Butterworths, 1983.
5. Reed, T.B., Biomass Gasification : Principles and Technology, Noyes Data Corporation, New Jersey, 1981.

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Understand the working principles, merits and limitations of fluidized bed systems
2. Apply fluidized bed systems for a specific engineering application.
3. Analyze the fluidized bed system to improve and optimize its performance

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓							
CO2	✓	✓								
CO3						✓			✓	

TPEEX0X	BIO ENERGY CONVERSION TECHNOLOGIES	L	T	P
		4	0	0

COURSE OBJECTIVES

- To pursue the various technologies for utilizing the bio-energy and its availability and conversion of bio-energy in the useful forms.
- Analyze elaborately the technologies available for conversion of biomass to energy in the technical update.
- Analyze the bio-energy conversion with respect to economical aspect and also in the environmental aspect.

Introduction of Biomass

Availability merits and demerits-Indian scenario-conversion mechanism- utilization of photo synthesis comparison with other energy.

Thermal Biomass Conversion

Combustion, pyrolysis, Gasification and Liquefaction-Biological Conversion-Methanol, Ethanol Production - Fermentation-Anaerobic Digestion Biodegradation and Biodegradability of Substrate.

Combustion

Perfect, complete and incomplete combustion-stoichiometric air requirement for biofuels - equivalence ratio-fixed bed and fluid Bed combustion-fuel and ash handling systems-steam cost comparison with conventional fuels.

Power Generation Techniques

Through Fermentation and Gasification-Biomass Production from different Organic Wastes-Effect of Additives on Biogas Yield-Biogas production from Dry Dung Cakes-Industrial

Application-Viability of Energy Production-Wood Gasifier System, Operation of Spark Ignition and Compression Ignition with Wood Gas Operation and Wood Gas Operation and Maintenance.

Economics and Environmental Aspects

Energy Effectives and Cost Effectiveness-History of Energy Consumption and Cost – Environmental Aspects of Bio-energy Conversion.

REFERENCES

1. David Boyles, Bio Energy Technologies Thermodynamics and Costs ,Ellis Hoknood,Chichester,1984
2. Khandelwal KC, Mahdi SS,Biogas Technology-A Practical Handbook, Tata McGraw Hil,1986.
3. R.C. Maheswari, Bio Energy for Rural Energisation, Concept Publication,1987
4. Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, Academic Press, New York,1980
5. EL-Halwagi MM, Biogas Technology: Transfer & Diffusion, Elsevier Applied SC, London 1986
6. Tom B Reed ,Biomass Gasification-Principles and Technology, Noyce Data Corporation,1981
7. Khandelwal KC, Mahdi SS, Biogas Technology-A Practical Handbook, Tata McGraw hill,1986

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Gain idea about the various forms of biomass.
2. Understand the various biomass energy conversion technologies and its importance.
3. Understand the economical and environmental aspect towards the present energy crisis.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓								✓	
CO2			✓			✓				
CO3	✓						✓		✓	

TPEEX0X	COGENERATION AND WASTE HEAT RECOVERY SYSTEMS	L	T	P
		4	0	0

COURSE OBJECTIVES

- To gain fundamental knowledge in energy generation, heat transfer in thermal engineering.
- To reduce the impact global warming for betterment of living things to serve healthy life.

Cogeneration

Introduction - Principles of Thermodynamics - Combined Cycles - Topping - Bottoming - Organic Rankine Cycles - Advantages of Cogeneration Technology

Application & Techno Economics of Cogeneration

Cogeneration Application in various Industries like Cement, Sugar Mill, Paper Mill etc. Sizing of Waste Heat Boilers - Performance Calculations - Part Load Characteristics. Selection of Cogeneration Technologies - Financial Considerations-Operating and Investments - Costs of Cogeneration

Waste Heat Recovery

Introduction - Principles of Thermodynamics and Second Law - Sources of Waste Heat Recovery - Diesel Engines and Power Plant etc.

Waste Heat Recovery Systems, Applications & Techno Economics

Recuperators - Regenerators - Economizers - Plate Heat Exchangers - Waste Heat Boilers - Classification, Location, Service Conditions, Design Considerations, Unfired Combined Cycle - Supplementary Fired Combined Cycle - Fired Combined Cycle Applications in Industries - Fluidised Bed Heat Exchangers - Heat Pipe Exchangers - Heat Pumps - Thermic Fluid Heaters Selection of Waste Heat Recovery Technologies - Financial Considerations - Operations and Investment Costs of Waste Heat Recovery.

Environmental Considerations

Environmental Considerations for Cogeneration and Waste Heat Recovery - Pollution

REFERENCES

1. Charles H Butler, Cogeneration, McGraw Hill Book Co., 1984
2. Horlock JH, Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford, 1987.
3. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London, 1963
4. Sengupta Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983
5. De Nevers, Noel., Air Pollution Control Engineering, Mcgraw Hill, New York, 1995

COURSE OUTCOMES

1. The students will acquire fundamental knowledge in energy generation, heat transfer in thermal engineering.
2. Students will get the ability solve problems using mathematical concepts and to use modern engineering tools, software and equipment to analyze and solve complex engineering problems.
3. The students will be able to solve real world problems and reduce the impact global warming for betterment of living things to serve healthy life.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓							
CO2			✓			✓	✓			
CO3	✓			✓					✓	

TPEEX0X	**COMPUTATIONAL HEAT TRANSFER**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES

- To impart fundamental mathematical concepts related to computational heat transfer.
- To impart fundamental mathematical concepts about fluid flow and heat transfer.
- To train students in the usage of computational codes and develop new ones.

Mathematical Description of Physical Phenomena

Governing Differential Equation - Energy Equation - Momentum Equation - Nature of Co-ordinates - Discretization Methods

Finite Difference Methods in Partial Differential Equations

Parabolic Equations - Explicit, Implicit and Crank Nicholson Methods. Finite Differences in Cartesian and Polar Co-ordinates. Local Truncation Error - Consistency Convergence - Stability - ADI Methods. Elliptic Equations - Laplace's Equation. Laplace's Equation in a Square - Non-rectangular Regions - Mixed Boundary Condition - Jacobi - Gauss- Siedel and SOR Methods. Necessary and Sufficient Conditions for Iterative Methods Finite Difference

Applications in Heat Condition and Convection

Control Volume Approach - Steady and Unsteady One Dimensional Conduction - Two and Three Dimensional Situations - Solution Methodology.

Convection and Diffusion

Upwind Scheme - Exponential Scheme. Hybrid Scheme - Power Law Scheme : Calculation of the Flow Field - Simpler Algorithm.

Finite Element Method Concept

General Applicability of the Method using one dimensional heat transfer equation - Approximate Analytical Solution - Raleigh's Method. Galerikin Method, Solution Methods.

Finite Element Method Packages - General Procedure - Discretisation of the domain - Interpolation Polynomials - Formulation of Element Characteristic Matrices and Vectors - Direct, Variational and Weighted - Residual Approach - Higher Order Isoparametric Element Formulations Conduction and Diffusion Equations - Heat Transfer Packages - Heat 2, HEATAX, RADIAT, ANSYS.

REFERENCES

1. Subash V.Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 1980
2. Jaluria and Torrance, Computational Heat Transfer - Faluria and Torrance, Hemisphere Publishing Corporation, 1986.
3. Mitchell A.R and Grifths D.F., Finite Difference Method in Partial Differential Equations, John Wiley & Sons, 1980.
4. Rao S.S., The Finite Element Methode in Engineering, Pergamon Press – 1989.
5. Zienkiewicz O.C. and Taylor R.L., The Finite Element Method IV Edition - Vol. I & II, McGraw Hill International Edition, 1991

COURSE OUTCOMES

1. The students will acquire fundamental knowledge in mathematical related to computational heat transfer in thermal engineering.
2. Students will get the ability solve problems using mathematical concepts.
3. The students will be able to solve real world problems using numerical methods.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓		✓						
CO2				✓						
CO3	✓		✓		✓					

TPEEX0X	**COMPUTATIONAL FLUID DYNAMICS**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES

Graduates are able to:

- Learn the physical significance of computational fluid dynamics as a design and research tool through derivation of governing equations.
- Understand to linearization of given mathematical behavior of flow field by finite difference method and obtain solution by numerical methods.
- Learn the implementation of FDM and numerical techniques in simple field behavior problems.

Philosophy of computational fluid dynamics

CFD as a research tool, CFD as a design tool, applications. Governing equations, their derivation, physical meaning and presentation of forms suitable to CFD.

Models of flow, continuity, momentum and energy equations, Navier- Stokes equation, Euler equation, physical boundary conditions. Mathematical behavior of partial differential equations, discrimination, finite differences, explicit and implicit approaches.

Grids with appropriate transformation

Transformation of equations, stretched grids, adaptive grids, mesh generation.

Simple CFD techniques

The Lax-Wendroff Technique, MacCormack's technique, relaxation technique, the alternating direction implicit technique, pressure correction method Leap frog and Crank Nicolsan method, upwind schemes

Some applications

Numerical solution of Quasi one-dimensional nozzle flows, incompressible coutte flow.

REFERENCES

1. Computational Fluid Dynamics, J.D.Anderson, Jr., Mc.Graw Hill, International Edition, 1995.
2. Numerical method for Scientific & Engineering, Joe D HoffMan, Mc.Graw Hill
3. Numerical method for Scientific & Engineering, Peter A.Stark, Mc.Graw Hill.
4. Chung T J "Computational Fluid Dynamics", Cambridge University Press, London, 2002

COURSE OUTCOMES

At the end of course, the graduates have ability to:

1. Describe the signification of flow field in energy engineering which imparts the knowledge of design and research as tool.
2. Formulate the linear equation of complex field behavior of mathematical governing equations through finite difference method which solves by numerical techniques.
3. Handle multidisciplinary task of work and used as modern engineering tools by the application of software which continues the updating of professional skills.

Mapping with Programme Outcomes:										
COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	✓		✓	✓					✓	
CO 2	✓			✓	✓					
CO 3		✓	✓	✓	✓		✓	✓		✓

TPEEX0X	ADVANCED ENGINES AND EMISSION SYSTEMS	L	T	P
		4	0	0

COURSE OBJECTIVES

- To explore recent trends, combustion modes and add on devices of automotive engines persisting in transportation system
- To reveal formation of pollution strategies of emission and control in in-cylinder combustion and after burn conditions.
- To understand measurement of exhaust emission using chassis dynamometer and trends in vehicle emission standards.

Advanced Engines

Advanced combustion modes – Gasoline Direct Injection (GDI) engine – stratified and homogeneous charge mode - ignition technology – plasma ignition – Common Rail Diesel Injection (CRDI) system – high pressure injection - Homogeneous Charge Compression Ignition (HCCI) engine - hybrid electric vehicles – fuel cells – add on devices - variable valve timing (VVT) – VTEC - downsizing and turbo charging

SI and CI Engine Combustion

Features of SI engine combustion processes - combustion process characterization – pre ignition and knocking- Thermodynamic analysis of burned and unburned mixture states - Combustion variations - factors affecting combustion - effect on performance and emissions - Features of CI engine combustion process - combustion process characterization - Ignition delay and factors affecting delay - air motion - Mixing controlled combustion and heat release rates - effect of engine design variables - - Thermodynamic analysis of CI engine combustion

Pollutant Formation

Pollutant formation in SI Engine - Unburned HC formation - HC oxidation in the cylinder and exhaust - exodus of HC contribution of different sources - Flame quenching in SI engines kinetics of NO and NO2 formation – CO and CO_2 – Pollutant formation in CI Engines Formation of HC in CI engines – effect of nozzle design and other variable - NO and NO2 formation in premixed and diffusion combustion periods. Formation of CO and kinetic effects - effect of engine variables - Composition of particulates - soot formation - soot structure - stoichiometric considerations, nucleation, growth and oxidation

Emission Control Systems

Strategies for emission control - emissions control inside the engine - EGR, crankcase and evaporative emission control - Exhaust gas after treatment - thermal and catalytic reactors - elements of reactors, catalysts and substrates – oxidation and reduction – Three way catalytic reactors - closed loop feedback control - catalyst deactivation mechanism - cold start HC control - Lean de-NOx catalysts - NOx traps and SCR- Diesel particulate filters (DPF) - DPF regeneration

Measurement of Emissions

Measurement of emissions - instrumentation for CO, HC, NOx, PM and smoke emissions - chassis dynamometer – isokinetic sampling - constant volume sampling (CVS) system – development of driving cycles – driving cycle tests procedures – European, US and Japan driving cycles - trends in vehicle emission standards - emission limits - national and international emission norms

REFERENCES

1. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill International Editions, 1989.
2. B. P. Pundir, Engine Emissions: Pollutant Formation and Advances in Control Technology, Narosa Publishing House, New Delhi, 2007.
3. Handbook of Air Pollution from Internal Combustion Engines: Pollutant Formation and Control, Ed. Eran Sher, Academic Press, 1998.
4. V Ganesan, Internal Combustion Engines (Fourth Edition)Tata McGraw-Hill Education Pvt. Ltd, 2013

COURSE OUTCOMES

1. Acquire knowledge on evolution of recent technologies for enhancement of internal combustion engines.
2. Understand the occurrence of combustion phenomena and their characterization in internal combustion engines.
3. Obtain knowledge of emission measurement test procedures and vehicle emission norms.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓			✓						
CO2	✓							✓	✓	
CO3			✓			✓			✓	✓

TPEEX0X	**FINITE ELEMENT METHODS IN THERMAL ENGINEERING**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES:

- To train students to acquire in depth mathematical knowledge related to finite element methods.
- To acquire knowledge to solve simple 1-dimensional and 2 -dimensional problems related to fluid flow and heat transfer.
- To train students to develop codes to solve real world problems in heat transfer equipments using finite element codes.

Overview of numerical methods – Discretised representation of physical systems – thermal resistance, flow resistance networks, thermal capacitance – Governing equations and Boundary conditions for thermal and flow systems.

Principles of variations calculus – applications of variational approach to one dimensional heat conduction – element matrix contribution and assembly.

Weighted residual methods – Galerkin's approach – Shape functions and interpolations – Application of Galerkin's weighted residual approach to one dimensional heat conduction – Three nodded triangular elements, 2 D steady state conduction using triangular elements – Radiation and natural convective boundary conditions – incorporation of variations in thermal properties.

Higher order elements and numerical integration solution of heat conduction and creeping flow using higher order element – Solution of convective heat transfer.

Incompressible laminar flow simulation – Stream function/Vorticity methods, Velocity Pressure formulation, mixed order interpolation for incompressible flow, modifications for turbulent flow. Application to heat exchanger. Description of programs for heat conduction, fluid flow, Assignment problems using these codes.

REFERENCES

1. The Finite Element Method in Engg., S.S.Rao Pergamon Press, 1990.
2. Applied Finite Element Analysis, Larry Segerlind John Wiley & Sons, 1988.
3. Finite Element Analysis Theory and Programming , C.S.Krishnamoorthy, Tata McGraw-Hill 1991.
4. Finite Element Methods, J.N.Reddy, McGraw-Hill, New York, 1988.
5. Finite Element Methods O.C.Zienkiewiez, McGraw-Hill, New York, 1980.
6. Introduction to Finite Elements in Engg., T.R.Chandrapatla and Belegundu, Prentice Hall of India, New Delhi, !985.
7. Finite Element Computational Fluid Mechanics – A.J.Baker, McGraw Hill, New York, 1978.

COURSE OUTCOMES

1. The students will gain knowledge to identify the problems in thermal engineering, formulate solutions through computational approaches.
2. The students will get the ability to analyze and solve convective heat transfer problems using numerical techniques.
3. Students will acquire ability to solve real world problems in the field of thermal engineering.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓		✓						
CO2				✓			✓			
CO3	✓		✓		✓					

TPEEX0X	THERMAL SYSTEM ANALYSIS	L	T	P
		4	0	0

COURSE OBJECTIVES

The curriculum is supposed to facilitate the students to:

- Develop the awareness of thermodynamics, heat transfer and fluid mechanics in the design of integrated thermal systems.
- Design thermal systems to meet desired need within realistic limitations such as economic, environmental, social, safety, manufacturability and sustainability.
- Gain knowledge about current issues and advances in engineering practices.

Design of Thermal System

Design Principles, Workable systems, Optimal systems, Matching of system components, Economic analysis, Depreciation, Gradient present worth factor.

Mathematical Modelling

Equation fitting, Nomography, Empirical equation, Regression analysis, Different modes of mathematical models, selection, computer programmes for models.

Modeling Thermal Equipments

Modelling heat exchangers, evaporators, condensers, absorption and rectification columns, compressor, pumps, simulation studies, information flow diagram, solution procedures.

Systems Optimization

Objective function formulation, Constraint equations, Mathematical formulation, Calculus method, Dynamic programming, Geometric programming, Linear programming methods, solution procedures

Dynamic Behavior of Thermal System

Steady state simulation, Laplace transformation, Feedback control loops, Stability analysis, Non-linearties.

REFERENCES

1. J.N. Kapur, Mathematical Modelling, Wiley Eastern Ltd., New York, 1989.
2. W.F. Stoecker, Design of Thermal Systems, McGraw Hill, 1980.
3. W.F. Stoecker, Refrigeration and Airconditioning, TMH, 1985.
4. Fanger P.O., Thermal Comport, McGraw Hill, USA, 1972.
5. McQuiston FC & Parker TD, Heating, Ventilating and Air conditioning, Analysis and Design, John Wiley & Sons, USA, 1988.

COURSE OUTCOMES

The students should be able to
1. Intend and pertain knowledge of mathematics, science and engineering
2. Propose a system, component or process to meet desired needs
3. Realize the professional and ethical conscientiousness

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓	✓							
CO2		✓	✓	✓			✓			
CO3					✓				✓	✓

TPEEX0X	**ENERGY CONSERVATION IN HVAC SYSTEMS**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES

- To understand the basic principles and latest developments in HVAC systems
- To understand the components and design principles used in air distribution systems.

First and Second Law Analysis - Thermodynamics of Energy conservation – Second law – Exergy – Irreversibility and efficiency – analysis of Refrigeration and Air-conditioning cycles, Heat pumps, Thermal insulation.

Energy Conservation - Modalities Energy auditing in Engineering and process Industry, Identifying avenues for Energy conservation, Conservation through periodic maintenance of HVAC systems, Predictive and Preventive maintenance

Refrigeration and Air-conditioning Equipment-Energy conservation in Air Handling units – Fans, Air-conditioning apparatus – Unitary equipments, Refrigeration Equipments – Reciprocating Refrigeration Machine, Centrifugal Refrigeration Machine, Absorption Refrigeration Machine, Heat Rejection Equipments, Energy Efficient motors.

Heating and Ventilating systems - Energy conservation feasibility analysis – conventional ventilating systems, constant volume induction system, Multizone unit system, Variable volume induction system, constant temperature systems. Heat Pipe Applications in Air-conditioning systems.

Heat conversion systems - Heat pumps - Vapour compression and vapour absorption systems - Theory of Heat transformers – Two temperature level, Three Temperature level.

REFERENCES

1. Carrier Air conditioning Co., Hand Book of Air conditioning System Design, McGraw Hill, 1985.

2. Plant Engineers and Manager's Guide to Energy Conservation, Fair Mount Press, 1987.
3. ASHRAE Hand Book – Equipments, 1989.
4. Georg Alefeld and Reinhard Radermacher, Heat conversation systems, CRC press, 1994.
5. Energy conservation in Heating, Cooling and Ventilating Buildings, Proceedings
6. Hemisphere publishing corporation, 1988.
7. Edward Hartmann, Maintenance Management, Productivity And Quality Publishing Pvt. Ltd. Madras, 1995.

COURSE OUTCOMES

1. Students will have a good understanding, knowledge, and comprehension of the theory and principals of HVAC equipment and their use.
2. Students will demonstrate a solid foundation of required technical skills for HVAC Installers and / or Serviced Techs.
3. Students will be able to identify and apply the principles and strategies necessary for hands-on installation, trouble-shooting, and servicing HVAC systems.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓	✓							
CO2			✓	✓		✓			✓	✓
CO3	✓		✓			✓	✓		✓	✓

TPEEX0X	**IC ENGINE COMBUSTION AND MEASUREMENT TECHNIQUES**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES

- To understand thermodynamics of combustion and stages of combustion process in SI and CI engines
- To learn formation of pollutants with respect to engine operating variables and their effects on environment
- To understand instrumentation for engine emission and driving cycle test procedures.

Combustion Basics

Air pollution from IC engines - primary and secondary pollutants- photochemical smog - Thermodynamics of combustion - Stoichiometry of combustion - heats of reaction and formation - adiabatic flame temperature - Chemical equilibrium - properties of equilibrium- combustion products of air-fuel mixtures -Introduction to chemical kinetics - order of reaction and reaction rates - Premixed combustion - flammability limits, SIT, flame structure - laminar and turbulent flames, flame speeds.

Combustion in SI Engines

Combustion in premixed and diffusion flames - combustion process in IC engines - stages of combustion - flame propagation - flame velocity and area of flame front - rate of pressure rise - cycle to cycle variation - abnormal combustion - theories of detonation - effect of engine operating variables on combustion – combustion chambers - types, factors controlling combustion chamber design.

Combustion in CI Engines

Vaporization of fuel droplets and spray formation – air motion - swirl, squish and turbulence - swirl ratio - fuel air mixing - stages of combustion - delay period - factors affecting delay period, knock in CI engines - methods of controlling diesel knock – CI engine combustion chambers – combustion chamber design objectives – open and divided – induction swirl, turbulent combustion chambers – air cell chamber - M combustion chamber.

Pollutant Formation

Pollution formation mechanism in SI and CI engine – sources of automotive pollution - formation of unburned hydrocarbons – nitrogen oxide – carbon monoxide and carbondioxide – particulate emission – soot – smog – different types of smoke - emission behavior at cold start – aldehydes – formation of polycyclic hydrocarbons – effect of pollution on health and environment.

Measurement Techniques

Data processing equipment – sensors - holographic measurement techniques for combustion phenomena – high speed photographic techniques – pressure transducer – cylinder pressure measurement – heat release analysis – inlet air flow measurement – sampling device - Non Dispersive Infrared (NDIR) analyzer - chemilluminescent analyzer - Flame Ionization Detector (FID) – smoke measurement – gas chromatography method – high performance liquid chromatography (HPLC) – particulate measurement – smoke and soot measurement - oxygen measurement – noise pollution measurement and control.

REFERENCES

1. Internal Combustion Engine Handbook, Ed. Richard Van Basshuysen and Fred Schafer, SAE International, 2004.
2. Internal Combustion Engines,. C.R. Ferguson, A. T. Kirkpatrick 2nd Edition, John Wiley & Sons, 2001
3. V Ganesan, Internal Combustion Engines (Fourth Edition)Tata McGraw-Hill Education Pvt. Ltd, 2013
4. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill International Editions, 1989.

COURSE OUTCOMES

1. Acquire knowledge of combustion phenomena related to engine variables of SI and CI engine.
2. Obtain knowledge of pollutant formation mechanism on various reasons.
3. Obtain knowledge of measurement techniques of combustion process and exhaust emission using various devices.

Mapping with Programme Outcomes										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	✓			✓					✓	
CO2		✓			✓					
CO3	✓					✓	✓		✓	

TPEEX0X	POWER PLANT MANAGEMENT	L	T	P	C
		4	0	0	3

COURSE OBJECTIVES

1. The course aims to equip the students with the analytical tools of economics and apply the skills for managerial decision making.
2. It seeks to develop economic way of thinking in dealing with practical problems and challenges.
3. To provide an idea of modern approaches to manage the power plant.

Managerial Economics

Concept of cost – Nature of profit – profit measurement – profit forecasting – depreciation – Depreciation calculation – value time function – straight line method – sinking fund method – sum of the years method – fixed percentage method and service output method – Calculation of capital recovered plus return in the above methods – depletion.

Replacement Studies

Types of replacement studies – annual cost present worth - rate of return – MAPT approach to replacement studies.

Budgetary Control

Various steps in budgetary control – basic concepts – break ever charts – setting targets for profits, sales – manufacturing – variable cost budgeting.

Power Plant Economics

Energy demand management energy cost and crisis – investors profits – types of tariffs – plant performance and operating characteristics – input curve – efficiency curve.

Personnel Management

Purposes of training – training techniques and aids – guide for selecting a trainer – training by induction. Maintenance Management- Functions and responsibilities of maintenance engineering department – preventive maintenance, equipment records and check lists – maintenance of power plant equipment – coal bunkers chutes. Pulverizing equipment – stokers – fuel oil equipment. Material management and inventory management Act, 1910 – the Indian electricity rules, 1956.

REFERENCES

1. Robert Henderson Emerick, Power plant Management , McGraw Hill, New York, 1965.
2. Production Handbook , Carson - et al. – John willey & Sons, New York, 1974.
3. Tara Chand, Engineering Economics, Nem Chand & Bros., Roorkee, 1988.
4. Murthy, P.S.R., Power system operation & control, Tata McGraw Hill, New Delhi, 1989.

COURSE OUTCOMES

1. To gather the knowledge of budgetary control and economics of power plant
2. To gain the managerial skills
3. Understand the training techniques of power plants.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1		✓		✓		✓	✓		✓	
CO2		✓		✓	✓			✓		
CO3		✓		✓	✓	✓		✓	✓	

TPEEX0X	PROCESS INSTRUMENTATION	L	T	P
		4	0	0

COURSE OBJECTIVES

- To educate students on different measurement systems and on common types of errors.
- To introduce different types of sensors, transducers, strain gauges, thermocouples, thermometers and flow meters used for measurement.
- To introduce control equipments and combined modes of control systems.

Fundamentals of process measurements, measurements of temperature

The air thermometer, thermodynamic viewpoints of temperature, the international practical temperature scale (IPTS) and ITS-90 scale- an overview. Introduction to instruments and their representation-application-functional elements or sensors-classification- microprocessor based instrumentation- standards and calibration; Static and dynamic performance of instruments, errors and uncertainties, propagation of measurement error into result.

Temperature and its measurement

Liquid-in-glass thermometers, principles and definitions, stem corrections, stability and accuracy; resistance thermometer, principles, sensors, circuits and bridges, resistance thermometer characteristics, circuit connection of PRT, thermistor; thermoelectric thermometry, historical development of basic relation, laws of thermoelectric circuits, thermoelectric circuit analysis; optical pyrometry, history, principles and calibration; temperature measurements in moving fluids, installation effects on temperature sensors; transient temperature measurements, first and second order response.

Pressure and its measurement

Concepts of pressure, pressure standards, mechanical and electrical pressure transducers, high and low pressure measurements, pressure measurement in moving fluids, transient pressure measurement

Flow and its measurements

Primary and secondary meters, positive displacement meters, invasive and non-invasive type flow meters.

Data analysis

An overview of basic statistical concepts, graphical representation and curve fitting of data, empirical correlation-linear fit, method of least square fit, error and uncertainty analysis.

REFERENCES

1. Robert P. Benedict, P.E 1984 Fundamentals of temperature, pressure, and flow measurements 3rd ed. New York: John Wiley & Sons.
2. Nakra, B.C. & Chaudhry K. K. 1994 Instrumentation, measurement and analysis 2nd ed. New Delhi: Tata McGraw-Hill Pub. Co. Ltd.
3. Holman, J.P., Experimental methods for engineers, McGraw-Hill, 1988.
4. Morris. A.S, Principles of Measurements and Instrumentation Prentice Hall of India, 1998.

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Gain knowledge about various instrumentation techniques
2. Perform dynamic modeling and study the system behavior
3. Apply control systems in various processes

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓			✓					✓	
CO2		✓				✓				✓
CO3	✓		✓						✓	✓

TPEEX0X	NUCLEAR ENGINEERING	L	T	P
		4	0	0

COURSE OBJECTIVES

- To acquire knowledge of technical competency combined with research to generate innovative solutions in Energy engineering
- To be acquainted with a variety of options in energy sources.
- To prepare the students to exhibit a high level of professionalism, integrity, environmental and social responsibility, and life-long independent learning ability

Review of nuclear physics

Nuclear equations – Energy from nuclear reactions and fission – Thermal neutrons – Nuclear cross-sections. Nuclear Reactions: Mechanism of Nuclear Fission and Fusion - Nuclides – Radioactivity - Decay chains-Neutron flux distribution is cores – slowing down – Neutron life cycle.

Reactor Materials:

Nuclear Fuel cycles - Characteristics of Nuclear Fuels - Uranium - Production and Purification of Uranium - Conversion to UF4 and UF6 - Other Fuels like Zirconium, Thorium - Berylium- Reactor heat generation and removal – Heat flow in and out of solid fuel elements – Axial temperature distribution of coolant and fuel element – Hot spot factors – Absorption of core radiation._Heat removal in slabs subjected to radiation – Thermal shields – Quality and void fractions in non-flow and flow systems – Boiling reactor hydraulics.

Boiling water reactor

Controlled Recirculation fluidized bed reactor – Gas cooled reactors – Radioactivity of gas coolants – Analysis of gas – steam cycle – simple and dual pressure cycle – Pebble bed reactors.

Liquid metal cooled reactors

Compatibility with materials – Types of Fast Breeding Reactors - Design and Construction of Nuclear reactors_– Fluid fueled reactors – types – corrosion and erosion characteristics – Safety aspects.

Separation of Reactor Products

Nuclear reprocessing – PUREX- UREX – TRUEX – FLOUREX. Waste Disposal and Radiation Protection: Types of Nuclear Wastes - Safety Control and Pollution Control.

REFERENCES

1. El-Wakil M.M., Nuclear Power Engineering, McGraw-Hill Book Co., New York, 1985.
2. Robert L. Loftness, Nuclear Power Plants: Design, Operating Experience, and Economics Van Nostrand, 1964.
3. P.K. Nag, Power Plant Engineering, Tata McGraw Hill Book Co., New Delhi, 2001.
4. S. Glasstone and A.Sesonske, Nuclear Reactor Engineering (3rd Edition), Von Nostrand, 1981.

5. J.R. Lamarsh, Introduction to Nuclear Reactor Theory, Wesley, 1966

COURSE OUTCOMES

1. An ability to acquire, apply and share in depth knowledge in the area of Nuclear physics and reactor materials.
2. An ability to have generate knowledge about different types of reactors and ore materials of uranium and thorium.
3. An ability to apply knowledge about Nuclear reprocessing, Waste Disposal and Radiation Protection methods.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓			✓			✓	
CO2		✓		✓						✓
CO3	✓		✓						✓	✓

TPEEX0X	**ALTERNATE FUELS FOR INTERNAL COMBUSTION ENGINE**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJCTIVES

- Learn various biofuel production methods and their characterization using various equipments.
- Describe the technique of reformation of biofuel fuel and alcohol fuel and its utilization in internal combustion engines.
- Understand the scenario of gaseous fuel utilization and their performance features in internal combustion engine

Bio fuel production and characterization

Vegetable oil – biofuel production methods – pyrolysis, fermentation, catalytic cracking and transesterification process – characterization of fuel – physical and chemical properties, Gas Chromatograph and Mass Spectroscopy (GC-MS) analysis, Fourier Transformation Infrared (FTIR) analysis, Thermo Gravimetric (TG) analysis and elemental analysis – suitability – merits and demerits

Reformation of liquid fuel

Reformation of liquid fuels – requirements and utilisation techniques – emulsions preparation – surfactant – ignition accelerators – nano particles in blends and neat form – storage and safety - characterization fuel - engine modification – dual fuelling – fuel induction mechanism – surface ignition – performance and emission characteristics of SI and CI engine

Alcohol fuel and fuel additives

Ethanol utilization in SI engine – prospects of methanol usage in CI engine – various methods of preparing bio additives – DEE, DME, and DIPE – cetane improvers – fuel oxygenates – bio surfactant – nanoparticles usage in biofuel – characterization of fuel – Scanning Electron Microscopic (SEM) analysis, Electron Dispersive Spectrum (EDS) analysis

Biogas utilization

Biomass sources – biogas production, collection and storage – gas analysis – GC-MS analysis – gas composition – cleaning of gas – non combustible gases and water vapour – engine modification and method of induction – gas carburettors – dual fuel mode in CI engine – performance feature of biogas on CI engine – merits and demerits of biogas utilization

Gaseous fuel

Hydrogen – Natural Gas (NG) and Liquefied Petroleum Gas (LPG) – Compressed Natural Gas (CNG) – gas analysis – properties – storage and safety precautions – engine modification – fuel induction method – gas injectors – injection methods – electronic engine management – performance of gaseous fuelled engine – combustion, performance and emission characteristics – merits and demerits

REFERENCES

1. Osamu Hiarao and Richard K. Pefiey, Present and Future Automotive Fuels. John Wiley and Sons, 1988.
2. Duffy Smith, Auto fuel systems, the Good Heart Willcox Company Inc. Publishers, 1987
3. Ashok V.Desai, Alternative Liquid Fuels, New Age International Publishers, 2004.
4. V Ganesan, Internal Combustion Engines (Fourth Edition)Tata McGraw-Hill Education Pvt. Ltd, 2013

COURSE OUTCOMES

1. Identify biofuel preparation methods and their characterization procedures using various devices.
2. Obtain knowledge of reforming liquid fuel and preparation of nano fuel blend.
3. Understand prospects of various gaseous fuels utilization in the transportation system.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1			✓	✓				✓		
CO2	✓			✓		✓	✓			✓
CO3	✓		✓						✓	

OPEN ELECTIVES

TPEEX0X	NUMERICAL ANALYSIS	L	T	P
		4	0	0

COURSE OBJECTIVES

- To understand the significance of numerical analysis in solving engineering problems
- To understand the basic concepts of mathematical modeling

Functional Approximation

Interpolation - divided difference, finite difference, Lagrangian, Chebychev, Hermite, Spline interpolations. Least squares methods - Orthogonal polynomial approximations, fourier approximations, fast fourier transforms. Types of errors - introduction to error analysis.

Numerical Calculus

Numerical differentiation. Numerical integration - Newton Cote's formulas, Gaussian quadrature formulas, adaptive quadrature. Solution of a system of linear equations - Gaussian elimination, Crout's method, Cholesky's method, Potter's, iterative methods.

Eigen value problems - Power and inverse power methods, Householder method, simultaneous iteration method, Lanczo's method.

Solution of Differential Equations

Initial Value problems - Euler's method, Runge-Kutta methods, Variable step methods. Boundary value problems - shooting method.

Unconstrained optimization - single variable minimization, multivariate minimization - direct search methods- Introduction to constrained optimization.

REFERENCES

1. Ralston and Rabinouitz P, "A first course in Numerical Analysis", McGraw Hill, 1978.
2. Hildebrand F.B., "Introduction to Numerical Analysis", Tata McGraw Hill, 1974.
3. Mathews, "Numerical Methods in Engineering and Science", PHI, 1995.
4. Rao S.S., "Optimisation Techniques", Wiley Eastern. Ltd., 1990.
5. Buchanan & Turner, "Numerical Methods and Analysis", McGraw Hill, 1992.

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Understand the common numerical methods used in engineering analysis
2. Estimate the amount of error inherent in different numerical methods.
3. Assess the efficiency of a selected numerical method when more than one option is available to solve a certain class of problem.

Mapping with Programme Outcomes										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	✓	✓							✓	
CO2	✓	✓				✓	✓		✓	
CO3			✓	✓		✓				

TPEEX0X	MICROPROCESSOR AND APPLICATIONS	L	T	P
		4	0	0

COURSE OBJECTIVES

- To learn and understand the development of microprocessor and microprocessor based system.
- To provide solid foundation on interfacing the external devices to the processor according to the user requirements to create novel products and solutions for the real time problems
- To assist the students with an academic environment aware of excellence guidelines and lifelong learning needed for a successful professional carrier

Digital Technology overview

Number systems – binary, decimal, hexadecimal – logic gates – OR, AND, XOR, NOT, NAND, NOR gates – Boolean Algebra – De Morgan's theorem – Karnaugh's map – encoders, decoders, adders, multiplexers, demultiplexers – RS, JK, D, T flip flops – Asynchronous counters – Shift register.

Microprocessor architecture

RAM, ROM, EPROM – memory mapping – INTEL 8085 Architecture – ALU, Registers, address bus, data bus, control buses, tristate devices – overview of 8086 16-bit microprocessor (Instruction set not included)

Microprocessor Programming

INTEL 8085 mnemonics – data transfer, arithmetic, logic, branching instructions – Subroutines – simple programs.

Interfacing and Peripheral devices

Basic interfacing concepts – 8085 interrupts, 8255 programmable peripheral interface – DMA controller – Basics of A/D & D/A conversion – 8085 compatible data converters.

Applications

Control of pressure, temperature, speed – stepper motor control – automotive applications – Microprocessor based monitoring and control of power plants (Concepts only)

REFERENCES

1. Gaonkar R.S., Microprocessor architecture, programming and applications, Wiley Eastern, 2001.
2. Mathur A.P., Introduction to microprocessor, Tata McGraw-Hill, 2000.
3. Barney G.C., Intelligent Instrumentation – Microprocessor applications in measurement and control, PHI, 1988.
4. Ahson S.I., Microprocessors with applications in process control, Tata McGraw-Hill, 1984.
5. Kent Stiffler A., Design with microprocessor architecture programming and applications, McGraw- Hill, 1992.

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Perform an in-depth knowledge of applying the concepts on real- time applications
2. Understand and capable of interfacing the microprocessor to the I/O devices.
3. Develop skill in writing simple arithmetic programmes for microprocessor.

Mapping with Programme Outcomes										
COs	**PO1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO1			✓			✓				✓
CO2				✓			✓			
CO3	✓					✓		✓	✓	

TPEEX0X	**WASTE MANAGEMENT AND ENERGY GENERATION TECHNIQUES**	**L**	**T**	**P**
		4	**0**	**0**

COURSE OBJECTIVES

- To familiarize students with recent energy generation techniques
- To provide information on various methods of waste management
- To detail on the recent technologies of waste disposal and
- To make student realize on the importance of healthy environment

Solid Waste

Definitions - Sources, Types, Compositions, Properties of Solid Waste - Municipal Solid Waste - Physical, Chemical and Biological Property - Collection - Transfer Stations - Waste Minimization and Recycling of Municipal Waste

Waste Treatment

Size Reduction - Aerobic Composting - Incineration - Furnace Type & Design, Medical / Pharmaceutical waste Incineration -Environmental Impacts - Measures to Mitigate Environmental effects due to Incineration.

Waste Disposal

Land Fill Method of Solid Waste Disposal - Land Fill Classification, Types, Methods & Siting Consideration - Layout & Preliminary Design of Land Fills - Composition, Characteristics, generation, Movement and Control of Landfill Leachate & Gases- Environmental Monitoring System for Land Fill Gases

Hazardous Waste Management

Definition & Identification of Hazardous Waste - Sources and Nature of Hazardous Waste - Impact on Environment - Hazardous Waste Control - Minimization and Recycling - Assessment of Hazardous Waste Sites - Disposal of Hazardous Waste, Underground Storage Tanks Construction, Installation & Closure Energy Generation from Waste: Types - Biochemical Conversion - Sources of Energy Generation - Industrial Waste, Agro Residues.

Anaerobic Digestion

Biogas Production - Types of Biogas Plant Thermochemical Conversion - Sources of Energy Generation - Gasification - Types of Gasifiers - Briquetting - Industrial Applications of Gasifiers - Utilization and Advantages of Briquetting - Environmental Benefits of Biochemical and Thermochemical Conversion

REFERENCES

1. Parker, Colin, & Roberts, Energy from Waste - An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985
2. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Prentice Hall, 2000.
3. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, 1997
4. Rich, Gerald et.al., Hazardous Waste Management Technology, Podvan Publishers, 1987
5. Bhide AD., Sundaresan BB, Solid Waste Management in Developing Countries, INSDOC New Delhi, 1983

COURSE OUTCOMES

Upon completion of the course, the students will be able to

1. Understand the waste characterization, segregation and disposal
2. Familiarize the technologies that are available for effective waste disposal
3. Understand the problem in a sensible and realistic manner

Mapping with Programme Outcomes										
COs	**PO1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**
CO1		✓		✓	✓				✓	✓
CO2	✓					✓			✓	✓
CO3									✓	✓

TPEEX0X	POWER PLANT INSTRUMENTATION AND CONTROLS	L	T	P
		4	0	0

COURSE OBJECTIVES

- To gain fundamental knowledge about instrumentation and control devices used in thermal power plant.
- To understand the various energy, thermal and mass flow measurement techniques.

Flow Measurement

Different types flow measurement for water flow, steam flow, furnace oil flow.

Pressure and Temperature measurement

Temperature measurement by Mechanical effect and by electrical effect – Thermocouples, pyrometry, transient response – Calibration methods – Thermo –electric effect instruments – varying resistance device – Quartz thermometers – Thermal property measurements – Measurements of Thermal conductivity, emissivity.

Boiler Control

Water level – air flow – furnace pressure – steam temperature – combustion – controls – master controller –burner management pulverizer control – mixed fuel control – PLC application – draft control – feed water control.

Turbine Control

Governor – over speed cut off – controls in combined cycle plants and PLC application – controls in cogeneration plants.

Data Acquisition Systems

Overview of A/D converter, types and characteristics –Sampling, Errors. Objective – Building blocks of Automation systems - Calibration, Resolution, Data acquisition interface requirements.

REFERENCES

1. David Lindsley, Boiler control systems, McGraw Hill, New York, 1992.
2. Doughles, Considine, Odenn , Process instruments and controls Hand book , McGraw Hill, New York,1981.
3. George C.Barney, Intelligent Instrumentation Microprocessor, Applications in Measurements and control, Prentice Hall, New Delhi, 1992.
4. Barnery, Intelligent Instrumentation, Prentice Hall of India, 1988.

COURSE OUTCOMES

1. The students will acquire fundamental knowledge about instrumentation and control devices used in thermal power plant.
2. Students will get the ability to measure energy, thermal and mass flow using direct measurement , indirect measurement and use of modern engineering tools, software and equipment to analyze and solve complex engineering problems.
3. The students will be able to solve real world problems and reduce the impact of global warming for betterment of living things to serve healthy life.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓							✓
CO2			✓			✓	✓			
CO3	✓			✓					✓	

TPEEX0X	MECHANICAL BEHAVIOUR OF MATERIALS	L	T	P
		4	0	0

COURSE OBJECTIVES

- To provide an understanding of the stress and strain distribution of metals during loading conditions and fracture of metals and also to introduce different test procedures.

Tensile behavior

Engineering stress-strain curve: Derivation of tensile strength, yield strength, ductility, modulus of elasticity, resilience and toughness from stress strain curves, comparison of stress-strain curves for different materials - True Stress - Strain Curve: true stress at maximum load, true fracture strain, true uniform strain, Necking strain - necking Criteria - Effect of strain rate, temperature and testing machine on flow properties - Notch tensile test - Tensile properties of steel - strengthening mechanisms - Strain hardening - Strain aging - Yield point phenomena - Solid solution strengthening - Martensite Strengthening - Grain refinement, Hall-Petch relation.

Hardness & toughness behavior

Hardness Measurements: Brinnell hardness, Meyer's hardness, Vickers hardness, Rockwell hardness and Microhardness - Relationship between hardness and the flow Curve - Hardness at elevated temperatures - Toughness measurements: Charpy, Izod and Instrumented Charpy - Transition Temperature Curves: significance, various criteria, metallurgical factors affecting the curves, Drop weight test, explosion crack starter test, Dynamic tear test and Robertson crack arrest test - Fracture Analysis Diagram.

Fatigue behavior

Introduction - Stress cycles, S-N curves Goodman diagram, Soderberg diagram, Gerbar diagram - Cyclic stress strain curve - Low cycle fatigue - Strain life Equation - Fatigue mechanisms - High cycle fatigue - Effect of following parameters on Fatigue: mean stress, stress concentration, specimen size, surface roughness, residual stress, microstructure and temperature. Fatigue crack propagation - Fatigue under combined stresses - Cumulative fatigue damage - Design for fatigue.

Fracture behavior

Types of fracture in metals: ductile and brittle fracture - Theoretical cohesive strength of metals - Griffth theory - Metallographic aspects of fracture - Fractography - Notch effect - Concept of fracture curve - Fracture under Combined Stresses - Environment sensitive fracture: hydrogen embrittlement stress corrosion cracking - Fracture mechanics: strain energy release rate, stress intensity factor, crack deformation modes, fracture toughness testing, plastic zone size correction, crack opening displacement, J-integral and R-curve.

Time dependant mechanical behavior

Creep curve - Stress rupture Test - Structural changes during creep - Mechanisms of creep deformation - Deformation mechanisms maps - Activation energy for steady state creep - Fracture at elevated temperature - Introduction to high temperature alloys - Predication of long time properties - Creep under combined stresses - Creep- Fatigue Interaction.

REFERENCES

1. Mechanical Metallurgy, George E.Dieter, Mc Graw Hill Book Company, New York, 1988.
2. Mechanical Metallurgy, M.A.Meyers and K K.Chawla, Prentice Hall Inc., Englewood Cliffs, NJ., 1962.
   Metals Handbook, Mechanical Testing, Vol.8, 9th edn., American Society for Metals, Metals Park, Ohio, 1985
3. Deformation and Fracture Mechanics of Engineering Materials, Hertzberg R.W. 2 nd edn., John Wiley & Sons, Inc., New York,1983.
4. Elementary Engineering Fracture Mechanics, Broek. D, 3rd edn., Martinus Nijhoff Publishing , The Hague, 1982.
5. Mechanical Behavoiur of Materials, Thomas Courtney. H, McGraw Hill 2nd Edition, 2000.

COURSE OUTCOMES

1. Understand the mechanical behaviour of metals.
2. Understand the environmental factors affecting the mechanical behaviour of materials.
3. Design the metals for specific applications.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓	✓							✓	✓
CO2				✓				✓	✓	
CO3			✓	✓						✓

TPEEX0X	METAL JOINING TECHNOLOGY	L	T	P
		4	0	0

COURSE OBJECTIVES

- To provide fundamental knowledge on welding metallurgy and weldability aspects of carbon steels, stainless steels, aluminum and titanium alloys, with an emphasis on various weldability testing methods and techniques.

Basic characteristics of fusion welds

Brief introduction to fusion welding process - Heat flow in welding: temperature distribution in welding, heat flow equations, simple problems, metallurgical effects of heat flow in welding, TTT diagrams, CCT diagrams - Metallurgy of fusion Weld: different zones of steel weldments and their properties, microstructure products in weldments.

Weldability of ferrous metals

Weldability of Carbon Steels, HSLA steels, Q&T steels, Cr-Mo steels, Significance of carbon equivalent, important problems encountered in welding of above steels and remedial steps - Weldability of Stainless Steels: stainless steel classification, Schaffler diagram, Delong diagram, WRC diagram problems associated with welding of austenitic stainless steel, ferritic stainless steel, martensitic stainless steel and duplex stainless steels.

Weldability of non-ferrous metals

Weldability of Aluminum alloys: Classification of aluminum alloys, various processes used for aluminum welding, problems involved in aluminum welding, precaution and welding procedure requirements, Weldability of Titanium alloys: classifications of titanium alloys, various welding processes and procedures involved in titanium welding problems involved and remedial steps - welding of nickel base alloys. and magnesium alloys.

Welding defects

Cracks: hot cracks, cold cracks, nomenclature, location and orientation of weld cracks, chevron cracks, lamellar cracks, reheat cracks, stress corrosion cracks - Residual Stresses: mechanism involved, types of residual stresses, measuring residual stress by hole drilling method, x-ray diffraction method, method of stress relieving, vibratory stress relief - Distortion: longitudinal, traverse, angular distortion, simple problems, bowing, rational distortion, buckling and twisting, controlling of distortions in weldments.

Weldability testing

Hot crack Tests: Murex test, Houldcroft test, Varestraint test, ring weldability test, hot ductility test - Cold Crack Tests: controlled thermal severity test, tekken test, lehigh test, longitudinal bead weld test, implant test - Service Weldability Tests: tensile test, nick break test, bend test, impact test, hardness test, fracture toughness test, fatigue test, creep test and corrosion test.

REFERENCES

1. Welding Engineering and Technology, Parmar R.S, Khanna Publishers, New Delhi. 1998
2. Welding Metallurgy, Linnert G.E, Vol I & II, 4th edition, American Welding Society, 1994
3. Introduction of Physical Metallurgy of Welding, Kenneth Easterling, 2nd Edition, Butterworth - Heinman, 1992.
4. The Metallurgy of Welding, Saferian.D, Pergamon Press, 1985.
5. Welding Metallurgy, Kuo S, Kohn Wiley, 1987.
6. Welding Hand Book, Welding Process Vol. II 8th Edition,American Welding Socity, 1991.
7. Welding Hand book,Material and Application Vol.III, 8thEdition, American -Welding Society, 1991.
8. Modern Arc Welding Technology, Nadkarni S.V, Oxford & IBH Publishing Co. Ltd., New Delhi

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Understand the basics of Physical Metallurgy, Welding Metallurgy and heat flow equations;
2. Understand and Inspect welding defects using Non-destructive testing methods;
3. Understand the Weldability testing , Weldability Service tests and Corrosion tests.

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✔			✔				✔	✔	
CO2		✔		✔				✔		✔
CO3		✔					✔		✔	

TPEEX0X	OPTIMIZATION TECHNIQUES	L	T	P
		4	0	0

COURSE OBJECTIVES

- To introduce methods of optimization
- To maintain a balance between theory, numerical computation, problem setup for solution by optimization software, and applications to engineering systems

Classical Optimization techniques

Unconstrained optimization – calculus of variations – Linear programming - Graphical and simplex methods – Duality

Non-linear Programming

Fibonacci method – Golden section method – Gradient descent method – Kuhn tucker conditions – method of Lagrangean multipliers – Quadratic programming – Wolfe's algorithm.

Integer linear programming

Gomory's cutting plane method – Stochastic linear programming – Geometric programming – Constrained and Unconstrained minimization problems.

Dynamic programming

Multi stage decision processes – Principle of optimality- tabular method – computational procedure.

Non traditional optimization algorithms

Genetic algorithm – working principle- Difference and similarities between GA and traditional methods-Applications in manufacturing problems- Neural network-Simulated annealing approach.

REFERENCES

1. Optimisation for Engineering Design, Kalyanamoy Deb., Eastern Economy Edition, Prentice Hall of India, 1998.
2. Optimisation Theory and Applications, Rao. S. S, Wiley Eastern Limited, 1995
3. Globally Optimum Design, Wild D. T., John Wiley & Sons, New Work, 1978
4. Mechanical Design Synthesis with Optimization Applications, Johnson. C. Ray, Von Nostrand, Reinhold Company, 1971.
5. Johnson Ray C., Optimum Design for Mechanical Elements John Wiley and Sons, New York, 1990.
6. GoldbergDE, Genetic Algorithms Search, Optimization and Machine, Barnen, Addison-Wesley, New York, 1989.

COURSE OUTCOMES

Upon successful completion of this course, the student will be able to understand:

1. Basic Theoretical Principles in Optimization;
2. Solution Methods in Optimization;
3. Applications to a Wide Range of Engineering Problems

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1			✓	✓		✓				
CO2						✓			✓	
CO3		✓	✓							✓

TPEEX0X	IMPACT ENGINEERING	L	T	P
		4	0	0

COURSE OBJECTIVES

- To impart an in-depth study of impact engineering with a focus on the current status of explosive metal working.

Explosives - Types - Propagation of ideal detonation - reaction zone. Shock waves - general considerations - Pressure, Impulses and energies of shocks generated by explosions in air and water Mechanics of energy transfer - ecometrical method - bubble phenomenon.

Stand-off and contact operations - parameters and applications. Interaction between explosion and work Piece in contact operation - Pressure time relation in metal- explosive system.Stress waves in solids - Microstructural changes - Hugoniot curves for iron and brass - changes in physical properties - fracturing under impulsive loads

Explosive welding of metals - Mechanism- Jetting collision Karman Vortex - Welding of semi cylindrical parallel plates - parameters welding window of dynamic angle of obliguity and velocity of welding - Transition from smooty to wavy flow - Loyer's welding window different types of explosive cladding setup - multilayered welding Applications - Metallurgy of explosive welding.

Explosive forming - strain energy of deformation - effect of explosive standoff and strain distribution in the explosive forming of flat circular blanks - Simple problems - Multiple shot explosive forming - Use of scale models in explosive Conning -explosive Conning dies- Effect of explosive forming on materials properties

Shock consolidation ceramics and composites - shock waves. The jump-relations- Equation (Hugoniot) – Compaction mechanism static versus shock compaction - different shock compaction techniques - (Cylindrical, Converged, Underwater and high temperature) - Temperature measurements - shock consolidation of bio-compatibles - ceramics - melt - infiltration of shock compacted ceramics - Metallurgy of shock consolidation

REFERENCES

1. Explosive working of metals and its applications, Bernard Cross land, Oxford University Press, 1983.
2. Explosive working of metals, Jolm Rineheart and John Pearson, Pergamon, London, 1985
3. Development of High Speed Forming, Davies and Austin, ASTME,1976.
4. High velocity forming of metals, Wilson, Prentice Hall of India Private Ltd., 1976

COURSE OUTCOMES

Upon successful completion of this course, the student will be able to

1. Understand the processes variables generated by explosions
2. Understand the environmental factors affecting the atmospheric contaminations
3. Study the metallurgical properties of explosive cladded process

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓		✓	✓			✓			✓
CO2		✓			✓				✓	
CO3			✓		✓		✓			✓

TPEEX0X	COMPOSITE MATERIALS	L	T	P
		4	0	0

COURSE OBJECTIVES

To impart an in-depth knowledge on composite materials, types, production processing and the structural development in composite materials.

Introduction: Fundamentals of composites – need for composites – Enhancement of properties – classification of composites - Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) Reinforcement - Particle reinforced composites, Fibre reinforced composites, Applications of various types of composites.

Classification of Polymers - properties and applications of selective engineering polymers - Polymer Matrix Composites: Polymer matrix resins - Thermosetting resins, thermoplastic resins - Reinforcement fibres - Rovings - Woven fabrics - Non Woven random mats - various types of fibres. PMC processes - Hand lay up processes - Spray lay up processes - Compression moulding - Reinforced reaction injection moulding - Resin transfer moulding Pultrusion - Filament winding - Injection moulding. Fibre reinforced plastics (FRP), (Glass fibre reinforced plastics (GRP)).

Metal Matrix Composites: Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC. Limitations of MMC, Metal Matrix, Reinforcements particles- fibres. Effect of reinforcement - Volume fraction - Rule of mixtures, Processing of MMC - Powder metallurgy process - diffusion bonding - stir casting, squeeze casting.

Ceramics Matrix Composites: Engineering ceramic materials - properties - advantages - limitations - Monolithic ceramics - Need for CMC Ceramic matrix - Various types of Ceramic Matrix composites - oxide ceramics - non oxide ceramics aluminium oxide - silicon nitride - reinforcements particles - fibres - whiskers. Sintering - Hot pressing Cold isostatic pressing (piping) - Hot isostatic pressing. (HIPing).

Advances Composites: Carbon/carbon composites - Advantages of carbon matrix - limitations of carbon matrix Carbon fibre - chemical vapour deposition of carbon on carbon fibre perform. Sol gel technique. Composites for aerospace industrial applications.

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1. Composite materials, Engineering and Science, Mathews .F.L. and Rawings .R.D., Chapman.
2. Composite materials, Chawla K.K., SpringerVerlag, 1987.
3. Engineering Materials, Kenneth G.Budinski, Prentice Pvt. Ltd., 41th Indian Reprint, 2002

4. Introduction to Metal Matrix Composites, T.W.Clyne and P.J. Withers, Cambridge University Press, 1993.
5. Fundamentals of Composite Manufacturing, B. Strong, SME, 1989.
6. Composite materials, S.C. Sharma, ", Narosa Publications, 2000.
7. Hand Book of Plastic processing, Brydson,

COURSE OUTCOMES

Upon completing this course, students should be able to:

1. Obtain knowledge on classification of composite materials used in the modern world
2. Obtain knowledge on different types of production technique of composite materials
3. Acquire knowledge on production of light weight composites that are used in aerospace industries

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	✓								✓	
CO2			✓							✓
CO3			✓				✓	✓	✓	