1st & 2nd YEAR, M. TECH.,

COURSE STRUCTURE AND SYLLABUS
FOR
THERMAL ENGINEERING
(AR22)
(Applicable for the batches admitted from 2022-23)

DEPARTMENT OF MECHANICAL ENGINEERING

ADITYA INSTITUTE OF TECHNOLOGY AND MANAGEMENT

(AN AUTONOMOUS INSTITUTION, PERMANENTLY AFFILIATED TO JNTUGV, VIZIANAGARAM)

Approved By AICTE, New Delhi, Accredited By NBA, AICTE & NAAC, UGC, New Delhi, Listed Under 2(F) & 12(B), UGC, New Delhi.

K.KOTTURU, TEKKALI,- 532 201, SRIKAKULAM DIST., AP

ADITYA INSTITUTE OF TECHNOLOGY AND MANAGEMENT (AUTONOMOUS)

Approved by AICTE, Accredited by NBA & NAAC, Recognised under 2(f)12(b) of UGC, Permanently Affiliated to JNTUGV, Vizianagaram. K.Kotturu, Tekkali, Srikakulam-532201, Andhra Pradesh

Academic Regulations for M.Tech

(Effective for the students admitted into first year from academic year 2022-2023)

The M.Tech Degree of the Aditya Institute of Technology and Management (Autonomous), Tekkali shall be conferred on candidates who are admitted to the program and fulfill all the requirements for the award of the Degree.

1.0 ELIGIBILITY FOR ADMISSIONS:

Admission to the above program shall be made subject to the eligibility, qualifications and specialization prescribed by the University from time to time. Admissions shall be made on the basis of merit / rank obtained by the qualifying candidate in GATE /PGCET, subject to reservations prescribed by the Govt. of AP from time to time.

2.0 AWARD OF M. Tech DEGREE:

2.1 A student shall be declared eligible for award of the M.Tech degree, if he/she pursues a course of study and completes it successfully in not less than two academic years and not more than four academic years.

2.2 A student, who fails to fulfill all the academic requirements for the award of the degree within four academic years from the year of his/her admission, shall forfeit his/her seat in M.Tech course.

2.3 The student shall register for all 68 credits and secure all the 68 credits.

3.0 ATTENDANCE:

3.1 The minimum instruction for each semester 90 clear instruction days.

3.2 A candidate shall be deemed to have eligibility to write End Semester examinations if he/she has put in a minimum of 75% of attendance in aggregate of all the subjects.

3.3 Condonation of shortage of attendance up to 10% (65% and above, and below 75%) may be given by the College academic committee.

3.4 Condonation of shortage of attendance shall be granted only on genuine and valid reasons on representations by the candidate with supporting evidence.

3.5 Shortage of attendance below 65% shall in NO case be condoned.

3.6 A candidate shall not be promoted to the next semester unless he/she fulfills the attendance requirements of the present semester.

3.7 A stipulated fee shall be payable towards condonation of shortage of attendance.

4.0 COURSE OF STUDY:

The following specializations are offered at present for the M.Tech course of study

1	VLSI System Design
2	Power Electronics and Drives
3	Computer Science and Engineering
4	Structural Engineering
5	Thermal Engineering

4.1 A standard academic format common for all PG programmes describing numbers of credits, weightage for lecture, laboratories work and projects have been fixed considering the scope of study. The position and sequence of study of core courses and elective courses are made to ensure sequential and integral learning. The focus on advance study in core courses through theory and laboratories work supported by study on relevant programme specific electives are incorporated. The selection of unique courses in the basket of elective is a special feature of curriculum ensuring flexibility and diversity. The emphasis on understanding advanced Concepts of PG course is ensured through elaborate practical work conducted through actual/virtual laboratory experiments. The concept of designing experiments and developing concept application is made part of learning process. The PG course is spread over two years in four semesters and inclusion of Minor project, Audit course, Open elective, Technical Seminar and Dissertation are the special features of this curriculum. The contents of course are unitized to facilitate its execution. The list of suggested reading is also made part of the curriculum.

4.2 The students are asked to learn IPR/ research methodology to understand the importance and process of creation of patents through research. The introduction of One Audit course covering subjects of developing desired attitude among the Learners is on the line of initiatives such as English for research paper writing, Disaster management, and Constitution of India and Personality development

through life enlightenment skills. The courses includedunder open electives are of importance in the context of special skill development and they are on Industrial safety, Operation research, Composite materials and Waste to Energy. These courses shall make students capable to work in industrial environment.

4.3 The introduction of Minor project ensures preparedness of students to undertake major projects/ dissertation. Students are encouraged to go to Industrial Training/Internship for at least 2-3 months during semester break. The dissertation/major project work of PG programme of one-year duration is given strong weightage in the curriculum. It is expected to undertake industrially relevant problem to develop an optimal solution through extensive research work. The students and faculty can design the research project in consultation with industry preferably in the region.

5.0 EVALUATION:

The performance of the candidate in each semester shall be evaluated subject-wise with a maximum of 100 marks for theory and 100 marks for laboratory, on the basis of continuous InternalEvaluation and Semester End Examination.

5.1 For Theory Courses, **40** marks shall be for internal evaluation and **60** marks for end semester examination. Out of **40** internal marks **30** marks are assigned for subjective exam, **5** marks for assignments and **5** marks for seminars. The internal evaluation for **30** marks shallbe made based on the average of the marks secured in the two Mid Term-Examinations conducted, one in the middle of the Semester and the other immediately after the completion of instruction. Each midterm examination shall be conducted for duration of 120 minutes and question paper shall contain 4 questions. The student should answer all 4 questions.

5.2 For courses like **Research Methodology & IPR** and **Open Elective,** the pattern of midterm and end examinations is similar to regular theory courses and the valuation is purely internal. Evaluation is based on continuous assessment.

5.3 Audit course is one among the compulsory courses and does not carry any Credits and no semester end examination.

5.4 For laboratory courses, **40** marks shall be for internal evaluation and **60** marks for end semester examination. Out of **40** internal marks **20** marks are assigned based on day-to-day evaluation and **20** are assigned based on the internal test. The end examination shall be conducted by the teacher concerned and an external examiner.

5.5 For Minor Project, **40** marks shall be for internal evaluation and **60** marks for end semester examination. The end semester examination (Viva-Voce) shall be

conducted by a committee. The committee consists of an External examiner, Head of the department and Supervisor of the minor project. The internal evaluation shall be made on the basis of seminar given by each student on the topic of his/her minor project, which was evaluated by Departmental committee. The Departmental Committee consists of Head of the Department, supervisor and one other senior faculty member from the Department. Out of **40** internal marks **10** marks allotted for literature survey, **15** marks for results and analysis and **15** marks for seminar.

5.6 For Technical Seminar there will be only internal evaluation for **100** marks. A candidate has to secure a minimum of **50%** marks to be declared successful. For evaluation the candidate has to collect literature on a topic, prepare the document, submit it to the Department in a report form and shall make an oral presentation before the Departmental Committee. The Departmental Committee consists of Head of the Department and two other senior faculty members from the department.

5.7 A candidate shall be deemed to have secured the academic requirement in a subject if he/she secures a minimum of 40% of marks in the end semester examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

5.8 In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.7) he has to reappear for the supplementary examination in that subject in the next academic year.

6.0 EVALUATION OF DISSERTATION Phase – 1/DISSERTATION Phase – 2 WORK:

Every candidate shall be required to submit thesis or dissertation after taking up a topic approved by the Dissertation Review Committee.

6.1 A DISSERTATION Review Committee (DRC) shall be constituted with Principal as chair Person, Head of the department, Supervisor and one senior faculty member of the concerned department.

6.2 Registration of DISSERTATION: A candidate is permitted to register for the Dissertation after satisfying the attendance requirement of all the subjects (theory and practical subjects) in Second semester.

6.3 After satisfying 6.2, a candidate has to submit, in consultation with his supervisor, the title, objective and plan of action of his dissertation work to the Dissertation Review Committee for its approval. After obtaining the approval of the Committee the student can initiate the dissertation work after the second semester

end examinations.

6.4 Every candidate shall work on dissertation approved by the DRC of the Department.

6.5 If a candidate wishes to change his supervisor or topic of the dissertation he can do so with approval of the DRC. However, the Dissertation Review Committee (DRC) shall examine whether the change of topic/supervisor leads to a major change of his initial plans of project proposal. If so, his date of registration for the dissertation work starts from the date of change of Supervisor or topic as the case may be.

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

6.7 The work on the dissertation shall be initiated in the beginning of the III semester and the duration of the dissertation is for two semesters. The candidate shall identify the problem, Literature survey, design/modeling part of the problem i.e. almost 35% of his dissertation work should be completed in the III semester itself and it will be evaluated by DRC as Dissertation Phase – 1. If the candidate fails to get the satisfactory report, he has to re-register for the dissertation work.

6.8 A candidate shall be allowed to submit the dissertation report only after fulfilling the attendance requirements of all the semesters with approval of DRC and not earlier than 40 weeks from the date of registration of the dissertation work. For the approval of DRC the candidate shall submit the draft copy of dissertation to the Principal (through Head of the Department) and shall make an oral presentation before the DRC.

6.9 The Candidate may be permitted to submit the Dissertation Report, if only the student pass in all subjects and work is Published/Accepted to be published in a Journal / International conference of repute and relevance.

6.10 Three copies of the Dissertation Report certified by the Supervisor shall be submitted to the College.

6.11 The Dissertation shall be adjudicated by external examiner from outside the college.

6.12 The viva-voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner outside the college.

The Board shall jointly report candidates work as:

A. Excellent
B. Good
C. Satisfactory
D. Unsatisfactory

Head of the Department shall coordinate and make arrangementsfor the conduct of viva-voce examination. If the report of the viva-voce is unsatisfactory, the candidate will retake the viva-voce examination after three months. If he fails to get a satisfactory report at the second viva-voce examination, the candidate may be asked to submit a new Dissertation proposal to DRC starting with 6.4

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

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

Table: Grading System for M.Tech. Programme

Percentage	Level	Letter Grade	Grade Points
>= 90%	Outstanding	A+	10
80 to <90%	Excellent	A	9
70 to <80%	Very Good	B	8
60 to <70%	Good	C	7
50 to <60%	Fair	D	6
< 50%	Fail	F	0
-	Absent	AB	0

7.1 Calculation of Semester Grade Points Average (SGPA)* for semester

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

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

Where CR = Credits of a Course
GP = Grade points awarded for a course

SGPA is calculated for the candidates who passed all the courses inthat semester.

7.2 Calculation of Cumulative Grade Points Average (CGPA) and Award of Division for Entire Programme.

The CGPA is calculated as below:

$$CGPA = \frac{\sum(CR \times GP)}{\sum CR}$$ (for entire programme)

Where CR = Credits of a Course
GP = Grade points awarded for a course

CGPA is calculated for the candidates who passed all the courses till that semester.

As per the AICTE regulations, conversion of CGPA into equivalent percentage as follows:
Equivalent Percentage = (CGPA – 0.75) x 10

After a student has satisfied the requirement prescribed for the completion of the programme and is eligible for receiving the award of M.Tech. Degree, he shall be placed in one of the below divisions:

Table: Award of Divisions

Class Awarded	CGPA Secured	Remarks
First Class with distinction	≥ 7.75 (Without any supplementary appearance)	From the CGPA secured from 68 Credits
First Class	≥ 6.75	
Second Class	≥ 6.0 and < 6.75	

8.0 WITH-HOLDING OF RESULTS:

If the candidate has not paid any dues to the college or if any caseof indiscipline is pending against him / her, the result of the candidate will be withheld and he/she will not be allowed into the next higher semester. The issue of the degree is liable to be withheld in such cases.

9.0 TRANSITORY REGULATIONS:

Candidate who have discontinued or have been detained for want of attendance or who have failed after having undergone the course are eligible for admission to the same or equivalent subjects as and when subjects are offered, subject to 5.8 and 2.0.

10.0 GENERAL:

10.1 The academic regulations should be read as a whole for purpose of any Interpretation.

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

10.3 The Institute may change or amend the academic regulations and syllabus at any time and the changes and amendments made shall be applicable to all the students with effect from the date notified by the college.

10.4 Wherever the word he, him or his occur, it will also include she, her and hers.

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ADITYA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, TEKKALI

(An Autonomous Institution)

M.TECH COURSE STRUCTURE

THERMAL ENGINEERING

M. Tech., (TE) - I SEMESTER						
Semester	**Subject Code**	**Subjects**	**L**	**T**	**P**	**C**
I	22MTE1001	Advanced Thermodynamics	3	0	0	3
	22MTE1002	Advanced Fluid Dynamics	3	0	0	3
		Program Elective – I				
	22MTE1003	Gas Dynamics	3	0	0	3
	22MTE1004	Turbo Machinery				
		Program Elective – II				
	22MTE1005	Air Conditioning System Design	3	0	0	3
	22MTE1006	Renewable Energy Technologies				
	22MTE1101	Thermal Science Lab	0	0	4	2
	22MTE1102	Computational Methods Lab	0	0	4	2
	22MCC1001	Research Methodology and IPR	2	0	0	2
		Audit Course - 1	2	0	0	0
	22MAC1001	English for Research Paper Writing				
	22MAC1002	Disaster Management				
	22MAC1003	Constitution of India				
	22MAC1004	Personality Development Through Life Enlightenment Skills				
Total			**16**	**0**	**8**	**18**
M. Tech (TE) – II SEMESTER						
Semester	**Subject Code**	**Subjects**	**L**	**T**	**P**	**C**
II	22MTE1007	Advanced Heat Transfer	3	0	0	3
	22MTE1008	Computational Fluid Dynamics	3	0	0	3
		Program Elective – III				
	22MTE1009	Thermal & Nuclear Power Plants	3	0	0	3
	22MTE1010	Experimental methods in Thermal Engineering				
		Program Elective – IV				
	22MTE1011	IC Engines and Combustion	3	0	0	3
	22MTE1012	Jet Propulsion and Rocketry				
		Program Elective –V				
	22MTE1013	Design of Solar and Wind Systems	3	0	0	3
	22MTE1014	Energy Conservation and Management				
		Open Elective				
	22MOE1001	Industrial Safety	3	0	0	3
	22MOE1002	Operations Research				
	22MOE1003	Composite Materials				
	22MOE1004	Waste to Energy				
	22MTE1103	Computational Fluid Dynamics Lab	0	0	4	2
	22MTE1201	Minor Project	0	0	4	2
Total			**18**	**0**	**8**	**22**

M. Tech. (TE) - III SEMESTER						
Semester	**Subject Code**	**Subjects**	**L**	**T**	**P**	**C**
III	22MTE2202	Technical Seminar	0	0	4	2
	22MTE2203	Dissertation Phase – I	0	0	20	10
Total			**0**	**0**	**24**	**12**
M. Tech (TE) - IV SEMESTER						
Semester	**Subject Code**	**Subjects**	**L**	**T**	**P**	**C**
IV	22MTE2204	Dissertation Phase – II	0	0	32	16
Total			0	0	32	**16**

L – Lecture hours/Week; T – Tutorial hours/Week;
P – Practical hours/ Week; C – Credits;

M. Tech., I Semester

ADVANCED THERMODYNAMICS

SUBJECT CODE: 22MTE1001

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. Apply engineering principles and analyze problems dealing with advanced thermodynamics.
CO 2. Construct PVT surface for real gases
CO 3. To understand the combustion process and analyse the parameters controlling combustion
CO 4. To learn and analyse the refrigeration cycles
CO 5. Discuss adaptability of phenomenological relations for irreversible process
CO 6. To learn and understand the working of fuel cells and photovoltaic cells

UNIT-I :

Review of Thermodynamic Laws and Corollaries – Transient flow analysis – Second law of thermodynamics – Entropy - Availability and unavailability – Irreversibility – Thermodynamic potentials – Maxwell relations – Specific heat relations – Mayer's relation - Evaluation of thermodynamic properties of working substance

UNIT-II :

P.V.T. surface – Equations of state – Real gas behaviour – Vander Waal's equation - Generalised compressibility factor – Energy properties of real gases – Vapour pressure – Clausius – Clapeyron Equation – Throttling – Joule – Thompson coefficient.

Non-reactive Mixture of perfect Gases – Governing Laws – Evaluation of properties – Psychrometric mixture properties and Psychrometric chart – Air conditioning processes – Cooling Towers – Real gas mixture.

UNIT-III :

Combustion – Combustion reactions – Enthalpy of formation – Entropy of formation – Reference levels for tables – Energy of formation – Heat of reaction – Adiabatic flame temperature general product – Enthalpies – Equilibrium.

Chemical equilibrium of ideal gases – Effects of non-reacting gases equilibrium in multiple reactions.

The Vant Hoff's Equation. The chemical potential and phase Equilibrium – The Gibbs phase Rule.

UNIT-IV :

Power cycles - Review binary vapour cycle, Co-generation and Combined cycles – Second law analysis of cycles – Refrigeration cycles.

UNIT-V :

Thermodynamics off irreversible processes – Introduction – Phenomenological laws – Onsager reciprocity relation – Applicability of the phenomenological relations – Heat flux and entropy production – Thermo dynamic phenomena – Thermo electric circuits.

UNIT-VI:

Direct Energy Conversion Introduction – Fuel Cells - Thermo electric energy – Thermo-ionic power generation -Thermodynamic devices - Magneto hydrodynamic generations – Photo voltaic cells.

TEXT BOOKS:

1. Basic and Applied Thermodynamics, P.K. Nag, TMH
2. Thermodynamics / Sonnatag & Van Wylen
3. Thermodynamics / Holman, Mc Graw Hill

REFERENCE BOOKS:

1. Thermodynamics / Doolittle – Messe
2. Irreversible Thermodynamics / HR De Groff.
3. Engg. Thermodynamics /PL.Dhar

M. Tech., I Semester

ADVANCED FLUID DYNAMICS

SUBJECT CODE: 22MTE1002

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. Describe Lagrangian and Eulerian fluid motion, stream and velocity potential functions, Euler and Bernoulli equations, continuity and momentum equations.

CO 2. Derive Navier-Stokes equations for viscous compressible flow and solve for simple cases like Plain and Hagen Poiseuille flow, Couette flow, Blasius solution.

CO 3. Derive Prandtl boundary layer theory and its approximate solutions for creeping motion. Compute drag coefficients for different velocity profiles.

CO 4. Describe fundamental concepts of turbulence including Van Driest model, k-epsilon model, Karman vortex trail. Calculate friction for internal flow using Moody's diagram.

CO 5. Explain basic concepts of compressible fluid flow including governing equations, flow regimes, mach cone.

CO 6. Design nozzles, diffusers for compressible flows using Fanno and Rayleigh Lines. Describe governing equations for expansion and compressible shocks, supersonic wave drag.

UNIT - I

Non – viscous flow of incompressible Fluids: Lagrangian and Eulerain descriptions of fluid motion- Path lines, Stream lines, Streak lines, Stream tubes – Velocity of a fluid particle, Types of flows, Equations of three dimensional continuity equation- Stream and Velocity potential functions.

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

UNIT - II

Principles of Viscous Flow: Derivation of Navier-Stoke's equations for viscous compressible flow – Exact solutions to certain simple cases : Plain Poiseuille flow - Couette flow with and without pressure gradient - Hagen Poiseuille flow - Blasius solution.

UNIT - III

Boundary Layer Concepts: Prandtl's contribution to real fluid flows – Prandtl's boundary layer theory - Boundary layer thickness for flow over a flat plate – Approximate solutions – Creeping motion (Stokes) – Oseen's approximation - Von-Karman momentum integral equation for laminar boundary layer — Expressions for local and mean drag coefficients for different velocity profiles.

UNIT - IV

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

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

M. Tech., I Semester

UNIT - V

Compressible Fluid Flow – I: Thermodynamic basics – Equations of continuity, Momentum and Energy - Acoustic velocity derivation of equation for Mach number – Flow regimes – Mach angle – Mach cone – Stagnation state

UNIT - VI

Compressible Fluid Flow – II: Area variation, Property relationships in terms of Mach number, Nozzles, Diffusers – Fanno and Rayleigh Lines, Property relations – Isothermal flow in long ducts – Normal compressible shock, Oblique shock: Expansion and compressible shocks – Supersonic wave drag.

TEXT BOOKS:

1. Schlichting H – Boundary Layer Theory (Springer Publications).
2. Yunus Cengel, John Cimbala - Fluid Mechanics
3. Faith A. Morrison - Fluid Mechanics

REFERENCE BOOKS:

1. Yuman S.W – Foundations of Fluid Mechanics.
2. An Introduction to Compressible Flow – Pai.
3. Dynamics & Theory and Dynamics of Compressible Fluid Flow – Shapiro.

M. Tech., I Semester

GAS DYNAMICS
(Elective - I)

SUBJECT CODE: 22MTE1003

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. Understand and analyze heat exchange cycles and application on gas turbines
CO 2. Understand the real cycles and can analyze the performance of turbo-jet engines
CO 3. Understand working principle of centrifugal compressors
CO 4. Understand working principle of axial flow compressors and its performance characteristics
CO 5. Understand the design and performance of combustion chambers
CO 6. Design and analysis of turbines and their performances

UNIT - I

Introduction: Classification of turbo machines, Applications of gas turbines, Assumptions for air-standard cycles, Simple Brayton cycle, Heat exchange cycle, Inter-cooling and Reheating Cycle, Comparison of various cycles.

Ideal Shaft Power Cycles and their Analysis: Assumptions for air-standard cycles, Simple Brayton cycle, Heat exchange cycle, Inter-cooling and reheating cycle, Comparison of various cycles.

UNIT - II

Real Cycles and their Analysis: Methods of accounting for component losses, Isentropic and Polytropic efficiencies, Transmission and combustion efficiencies, Comparative performance of practical cycles, Combined cycles and cogeneration schemes.

Jet Propulsion Cycles and their Analysis: Criteria of performance, Simple turbojet engine, Simple turbofan engine, Simple turboprop engine, Turbo-shaft engine, Thrust augmentation techniques.

UNIT - III

Fundamentals of Rotating Machines: General fluid dynamic analysis, Euler's energy equation, Components of energy transfer, Impulse and Reaction machines.

Centrifugal Compressors: Construction and principle of operation, Elementary theory and velocity triangles, Factors effecting stage pressure ratio, The diffuser, The compressibility effects, Pre-rotation and slip factor, Surging and Choking, Performance characteristics.

UNIT - IV

Axial Flow Compressors: Construction and principle of operation, Elementary theory and velocity triangles, Factors effecting stage pressure ratio, Degree of reaction, Work done factor, Three Dimensional flow, Design process, Blade design, Stage performance, Compressibility effects, Off-design performance.

UNIT - V

Combustion System: Operational requirements, Classification of combustion chambers, Factors effecting combustion chamber design, The combustion process, Flame stabilization, Combustion chamber performance, Some practical problems gas turbine emissions.

M. Tech., I Semester

UNIT - VI

Axial and Radial Flow Turbines: Construction and operation, Vortex theory, Estimation of stage performance, Overall turbine performance, Turbine blade cooling, The radial flow turbine.

Off-Design Performance: Off-Design performance of single shaft gas turbine, Off-Design performance of free turbine engine, Off-Design performance of the Jet Engine, Methods of displacing the equilibrium running line

TEXT BOOKS:

1. H Cohen, GFC Rogers and HIH Saravanamuttoo, "Gas Turbine Theory", Pearson Education, 2000.
2. S. M. Yahya "Turbines, Compressors and Fans", Tata McGraw Hill, 1992.

REFERENCES:

1. Vincent "The theory and design of Gas Turbine and Jet Engines", McGraw Hill, 1950.
2. W W Bathic, "Fundamentals of Gas Turbines", John Wiley and Sons.
3. V. Ganesan, "Gas Turbines", Tata McGraw Hill, 2003.

M. Tech., I Semester

TURBO MACHINERY
(Elective - I)

SUBJECT CODE: 22MTE1004

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. To understand the basic concepts and flow equations applicable for turbomachines
CO 2. Understand and analysis of pumps
CO 3. To understand the operating principles of various turbomachines and analyze their use for various engineering applications.
CO 4. To understand and analyze the design of fans and propellers
CO 5. To understand and analyze the design of centrifugal compressors
CO 6. To understand and analyze the design of axial turbines

UNIT - I

Introduction to Turbomachines. Classification of Turbomachines. Second law of Thermodynamics - turbine/compressor work, Nozzle/diffuser work. Fluid equations - continuity, Euler's, Bernoulli's equation and its applications. Expansion and compression processes, Reheat factor, Preheat factor.

UNIT - II

Euler's equation of energy transfer, Vane congruent flow, Influence of relative circulation, Thickness of vanes, Number of vanes on velocity triangles, Slip factor, Stodola, Stanitz and Balje's slip factor. Suction pressure and net positive suction head.

UNIT – III

Phenomena of cavitation in pumps. Concept of specific speed, Shape number. Axial, Radial and Mixed Flow Machines. Similarity laws.

UNIT – IV

Flow through Axial flow fans. Principles of Axial fan and propeller. Application of fans for air circulation and ventilation. Stage pressure rise and work done. Slip stream and blade element theory for propellers. Performance and characteristics of axial fans.

UNIT - V

Flow through Centrifugal compressors. Stage velocity triangles, Specific work. Forward, radial and backward swept vanes. Enthalpy entropy diagram, Degree of reaction, Slip factor, Efficiency. Vane less and vaned diffuser systems, Volute as spiral casing. Surge and stall in compressors.

UNIT - VI

Axial turbine stages, Stage velocity triangles, Work, Efficiency, Blade loading, Flow coefficient.
Single stage impulse and reaction turbines, Degree of reaction, 50% reaction turbine stage, Radial equilibrium and Actuator disc approach for design of turbine blades.
Partial admission problems in turbines. Losses in turbo machines.

TEXT BOOKS:

1. S.M. Yahya, Turbines, Compreessors and Fans, Tata Mcgraw Hill.
2. Gopalakrishnan G, Prithvi Raj D, "A treatise on Turbomachines", Scitec Publications, Chennai, 2002.

REFERENCES BOOKS:

1. R.K.Turton, Principles of Turbomachinery, E & F N Spon Publishers, London & New York.
2. Balajee, Designing of Turbomachines.
3. Sheppard, Principles of Turbomachinery.

M. Tech., I Semester

AIR CONDITIONING SYSTEM DESIGN
(Elective - II)

SUBJECT CODE: 22MTE1005

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. Understand the fundamentals of Psychrometry.
CO 2. Apply human comfort indices and comfort chart to design indoor conditions of HVAC systems.
CO 3. Estimate heating and cooling loads for buildings according to ASHRAE procedures/standards.
CO 4. Design and evaluate complete air distribution system including fan, duct, and installation requirements for a typical HVAC system
CO 5. To understand the air conditioning control systems
CO 6. Understand the various heat pumps and its performance

UNIT - I

Psychrometry: Properties of Moist air- Psychrometric relations – Psychrometric chart – Psychrometric processes in air-conditioning equipment – Bypass factor – Sensible heat factor.

Applied Psychrometry: Effective and grand sensible heat factors- Selection of Air- Conditioning apparatus for cooling and dehumidification - All outdoor air application.

UNIT - II

Air-conditioning Processes – Mixing process- Summer, Winter and Year- round air conditioning systems – hot and dry out door condition, Hot and humid outdoor condition – winter air conditioning system – Year round air- conditioning system. Process of cooling, Heating and Dehumidifying coils – Air washers – Cooling by dry and wet coils – Adiabatic dehumidifier – Humidifier- Water injection – Steam injection.

UNIT - III

Requirements of Comfort Air-conditioning – Thermodynamics of human body – Body regulation process against heat or cold – comfort and comfort chart – Effective temperature – Factors governing optimum effective temperature – Design considerations – Selection of outside and inside design conditions.

UNIT - IV

Ventilation systems: Natural ventilation systems – Mechanical – Extraction system – Supply systems – Combined supply and extraction systems – Air cleaning – Equipment used for odour suppression and air sterilization.

UNIT - V

Air-conditioning controls systems – Basic elements of the control systems – temperature, humidity and pressure controls and refrigeration flow controls

UNIT - VI

Heat pump – Different heat pump circuits air, ground water, earth – The linked air cycle heat pump – Drying of materials.

M. Tech., I Semester

TEXT BOOKS:

1. Reinhold Co., New York, 1984. 7. Arora C.P., "Refrigeration & Air Conditioning", Tata Mc Graw Hill, 1985.
2. Manohar Prasad, "Refrigeration & Air Conditioning", New Age Publishers.
3. ASHRAE Handbook.
4. "Handbook of air-conditioning system design", Carrier Incorporation, McGraw Hill Book Co. U.S.A, 1965.
5. Norman C. Harris, "Modern Air Conditioning", New York, McGraw-Hill,1974.
6. Jones W.P., "Air Conditioning Engineering", Edward Arnold Publishers Ltd., London, 1984.

REFERENCES BOOKS:

1. Hainer R.W., "Control Systems for Heating, Ventilation and Air-Conditioning", Van Nostrand
2. "Refrigeration and air-conditioning", ARI, Prentice Hall, New Delhi, 1993.
3. Stoecker, "Refrigeration & Air Conditioning", Mc Graw Hill, 1992.
4. Stoecker, "Design of Thermal Systems", Mc Graw Hill, 1992.

M. Tech., I Semester

RENEWABLE ENERGY TECHNOLOGIES
(Elective - II)

SUBJECT CODE: 22MTE1006

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. To understand the solar energy and need for non-conventional energy resource
CO 2. To understand the working principle of geothermal energy
CO 3. To understand the process of fusion and use of hydrogen gas as fuel
CO 4. To understand the working of biogas plant
CO 5. To understand the harnessing of wind energy
CO 6. To understand the harnessing of tidal energy

UNIT-I

INTRODUCTION: Energy Scenario, Survey of energy resources, Classification and need for conventional energy resources.

SOLAR ENERGY: Sun, Earth relationship, Basic matter to waste heat energy circuit, Solar radiation, Attention, Radiation measuring instruments.

SOLAR ENERGY APPLICATIONS: Solar water heating, Space heating, Active and passive heating, Energy storage, Selective surface, Solar stills and ponds, solar refrigeration, Photovoltaic generation.

UNIT -II

GEOTHERMAL ENERGY: Structure of earth, Geothermal Regions, Hot springs. Hot rocks, Hot aquifers. Analytical methods to estimate thermal potential. Harnessing techniques, Electricity generating systems.

UNIT-III

DIRECT ENERGY CONVERSION: Nuclear Fusion, Fusion reaction, P-P cycle, Carbon cycle, Deuterium cycle, Condition for controlled fusion, Fuel cells and photovoltaic, Thermionic & thermoelectric generation, MHD generator.

HYDROGEN GAS AS FUEL: Production methods, Properties, I.C. engine applications, Utilization strategy, Performance.

UNIT-IV

BIO ENERGY: Biomass energy sources, Plant productivity, Biomass wastes, aerobic and anaerobic bioconversion processes, Raw material and properties of biogas, Biogas plant technology and status, the energetic and economics of biomass systems, Biomass gasification

UNIT-V

WIND ENERGY: Wind, Beaufort number, Characteristics, Wind energy conversion systems, Types, Betz model. Interference factor. Power coefficient, Torque coefficient and Thrust coefficient, Lift machines and Drag machines. Matching, Electricity generation.

UNIT-VI

ENERGY FROM OCEANS: Tidal energy, Tides, Diurnal and semi, diurnal nature, Power from tides, Wave Energy, Waves, Theoretical energy available. Calculation of period and phase velocity of waves, Wave power systems, Submerged devices. Ocean thermal Energy, Principles, Heat exchangers, Pumping requirements, Practical considerations.

M. Tech., I Semester

TEXT BOOK:

1. Renewable Energy Resources/ John Twidell& Tony Weir/Taylor & Francis/2nd edition
2. Renewable Energy Resources, Basic Principles and Applications/ G.N.Tiwari and M.K.Ghosal/ Narosa Publications

REFERENCES:

1. Biological Energy Resources/ Malcolm Fleischer & Chris Lawis/ E&FN Spon
2. Renewable Energy Sources / G.D Rai /Khanna Publishers

M. Tech., I Semester

THERMAL SCIENCE LAB

SUBJECT CODE: 22MTE1101

L	T	P	C
0	0	4	2

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. Acquire hands on experience on the various test-rigs, Experimental set up.
CO 2. Identify the effect of various parameters on the system and able to correlate them.
CO 3. Study the performance and emission characteristics of IC engine
CO 4. Impart the knowledge of various alternate fuels for IC engines
CO 5. Understand the thermodynamic relations of thermal engineering devices
CO 6. Understand the working principle of different heat transfer equipments

LIST OF EXPERIMENTS:

1. Compressibility factor measurement of different real gases.
2. Dryness fraction estimation of steam.
3. Performance test and analysis of exhaust gases of an I.C. Engine.
4. Heat Balance sheet, Volumetric Efficiency and air fuel ratio estimation of an I.C. Engine.
5. COP estimation of vapour compression refrigeration test rig.
6. Performance analysis of Air conditioning unit.
7. Pin-Fin Apparatus: Determination of temperature distribution, efficiency and effectiveness of the fin working in forced convection environment.
8. Performance analysis of heat pipe.
9. Solar Flat Plate Collector Performance
10. Evacuative tube concentrator Performance
11. Calibration of temperature measurement apparatus.

M. Tech., I Semester

COMPUTATIONAL METHODS LAB

SUBJECT CODE: 22MTE1102

L	T	P	C
0	0	4	2

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. Conduct steady state thermal analyses and determine the temperatures at key locations of heated structures.

CO 2. Conduct transient thermal analyses and determine the temperatures at key locations of heated structures.

CO 3. Write C/Matlab Programs to solve differential equations using numerical methods.

CO 4. Perform various analyses for the modes of heat transfer in different structures and components.

CO 5. To analyse fluid flow and heat transfer in mechanical structures

CO 6. Solve problems related to laminar and turbulent flows using computational fluid dynamics software package.

Introduction to finite element analysis and CFD packages ANSYS or NASTRAN.

LIST OF EXPERIMENTS

1. Steady state thermal analysis of a casting. **[CO 1]**
2. Steady state thermal analysis of composite slab. **[CO 1]**
3. Transient thermal analysis of fins with circular and triangular cross sections. **[CO 2]**
4. Write C Programs to solve differential equations using Runge Kutta method. **[CO 3]**
5. Develop MATLAB code to solve differential equations of fluid flow. **[CO 3]**
6. Thermal Analysis of a double pipe heat exchanger. **[CO 4]**
7. Fluid flow and heat transfer in a mixing elbow pipe. **[CO 4]**
8. Laminar flow simulation of a pipe. **[CO 5]**
9. Turbulent flow simulation of a pipe. **[CO 5]**
10. Laminar flow simulation of a flat plate **[CO 5]**

M. Tech., I Semester

RESEARCH METHODOLOGY AND IPR

SUBJECT CODE: 22MCC1001

L	T	P	C
2	-	-	2

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. Understand research problem formulation.
CO 2. Analyze research related information
CO 3. Follow research ethics and the methodology to review the literature
CO 4. Interpret the data with various techniques and to write a technical report
CO 5. Get prior knowledge on patents procedures and Intellectual Property
CO 6. Understand the scope of patent rights

UNIT - I

Research Methodology: Introduction, Meaning of research, Objectives of research, Motivation in research, Types of research, Research approaches, Significance of research, Research methods versus methodology, Research and scientific method, Importance of Knowing How Research is Done, Research process,

UNIT - II

Criteria of Good Research: Problems encountered by researchers in India. Defining the research problem: Research problem, Selecting the problem, Necessity of defining the problem, Technique involved in defining a problem, an Illustration

UNIT - III

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, Searching the existing literature, Reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed, Analysis plagiarism, and Research ethics.

UNIT - IV

Interpretation and Report Writing: Meaning of interpretation, Technique of interpretation, Precaution in interpretation, Significance of report writing, Different steps in writing report, Layout of the research report, Types of reports, Oral presentation, Mechanics of writing a research report, Precautions for writing research reports.

UNIT - V

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

UNIT - VI

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology, Patent information and databases. Geographical indications. New developments in IPR: Administration of patent system. New developments in IPR; IPR of biological systems, Computer software etc, Traditional knowledge case studies, IPR and IITs.

TEXT BOOKS:

1. Research methodology by C.R. KOTHARI
2. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

REFERENCE BOOKS

1. Research Methodology, Paneersevam, PHI
2. Research Methodology, Chawla and Sondhi, Vikas
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.

M. Tech., I Semester

ENGLISH FOR RESEARCH PAPER WRITING
(Audit Course – I)

SUBJECT CODE: 22MAC1001

L	T	P	C
2	0	0	0

COURSE OUTCOMES :

CO 1. Students will be able to write paper with clarity and brevity
CO 2. Students will be able to interpret their findings in their own way unaffected by external factors
CO 3. Students will be able to get accurate results with an astute understanding of the subject
CO 4. Students will be able to begin paper writing more aptly
CO 5. Students will be able to write methods, results, discussions and conclusion in their paper more logically
CO 6. Students will be able to use phrases competently to express their ideas

UNIT – I

Planning and preparation, Word order, Breaking up long sentences, Structuring paragraphs and sentences, Being concise and removing redundancy, Avoiding ambiguity and vagueness

UNIT – II

Clarifying who did what, Highlighting findings, Hedging and criticizing, Paraphrasing and plagiarism, Sections of a paper, Abstracts, Introduction

UNIT – III

Review of the Literature, Methods, Results, Discussion, Conclusions, Final check.

UNIT – IV

Key skills needed when writing a title, An abstract, An introduction and a review of the literature.

UNIT – V

Skills needed when writing methods, Results, Discussions and Conclusion.

UNIT – VI

Useful phrases, how to ensure paper is as good as it could possibly be the first- time Submission.

TEXT BOOKS:

1. Goldbort R (2006). *Writing for Science*. Yale University Press.
2. Day R (2006). *How to Write and Publish a Scientific Paper*. Cambridge University Press.
3. Highman N (1998). *Handbook of Writing for the Mathematical Sciences*, SIAM. Highman's book.

M. Tech., I Semester

DISASTER MANAGEMENT
(Audit Course – I)

SUBJECT CODE: 22MAC1002

L	T	P	C
2	0	0	0

COURSE OUTCOMES:

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

CO 1. Know the Disaster Concepts to Management.
CO 2. Ability to Categorize Disasters & Preparedness plans for disaster response.
CO 3. Ability to analyze seismic vulnerable location in various parts of India
CO 4. Monitoring and evaluation plan for disaster response, setting up of early warning systems for risk reductions
CO 5. Ability to analyze seismic vulnerable location in various parts of India
CO 6. Analyze the statistical approach on land slides

UNIT – I

Concept of Disaster Management. Types of Disasters. Disaster mitigating agencies and their organizational structure at different levels

UNIT – II

Overview of Disaster situations in India: Vulnerability profile of India and vulnerability mapping including disaster – prone areas, communities, places.

UNIT – III

Disaster preparedness – ways and means; skills and strategies; rescue, relief, reconstruction and rehabilitation.

UNIT – IV

Case studies: Lessons and experiences from various important disasters in India.

UNIT – V

Seismic vulnerability of urban areas.: Seismic response of R.C. frame buildings with soft first storey. Preparedness for natural disasters in urban areas. Sulabh technology for sanitation improvement in urban habitat. Landslide hazards zonation mapping and geo-environmental problems associated with the occurrence of landslides.

UNIT – VI

Statistical approach to study landslides: Landslide casual factors in urban areas. Roads and landslide hazards in Himalayas. Lateral strength of masonry walls. A numerical model for post earthquake fire response of structures. Cyclone resistant house for coastal areas. Disaster resistant construction role of insurance sector. Response of buried steel pipelines carrying water subjected to earthquake ground motion. Preparedness and planning for an urban earthquake disaster. Urban settlements and natural hazards. Role of knowledge based expert systems in hazard scenario.

TEXT BOOKS:

1. Natural Hazards in the Urban Habitat" by Iyengar, C.B.R.I., Tata McGraw Hill.
2. Natural Disaster management", Jon Ingleton(Ed), Tulor Rose
3. Disaster Management", R.B. Singh (Ed), Rawat Publications,2006
4. Anthropology of Disaster management", Sachindra Narayan, Gyan Publishing House,2000

M. Tech., I Semester

CONSTITUTION OF INDIA
(Audit Course – I)

SUBJECT CODE: 22MAC1003

L	T	P	C
2	0	0	0

COURSE OUTCOMES:

By the end of this course the student will be able to:

CO 1. Realize the rigidness of our Indian Politics and Administrative aspects.
CO 2. A Student can understand our nation federalism.
CO 3. Can assess different types of risks involved in misadministration.
CO 4. Can create competitive advantage.
CO 5. Summarizes the legal, Administrative, Political and Financial aspects for betterment of the National building.
CO 6. To assess the growth of Indian opinion regarding modern Indian intellectuals' Constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism

UNIT – I

Introduction: Historical perspective of the constitution of India - Salient features of The Indian Constitution –Features: Fundamental Rights (Article 12 to 35), Duties (51 A – 1976 emergency) and Directive principles (Article 36 to 51) of State Policy - Articles 14 to 18- Articles 19 - Article 21

UNIT-II

Amendment Procedure of The Indian Constitution: 42nd amendment (Mini Constitution) - 44th amendment (1978 – Janatha Govt.)

UNIT – III

Local Administration: District's administration head: Role and Importance, Municipalities: Introduction, Mayor and role of elected representative, CEO of municipal corporation, Pachayati raj: Introduction, PRI: ZilaPachayat, Elected officials andtheir roles, CEO ZilaPachayat: Position and role, Block level: Organizational Hierarchy (Different departments),Village level: Role of elected and appointed officials, Importance of grass root democracy.

UNIT – IV

Parliamentary form of Govt. In India: President of India - Emergency provisions - National Emergency – Article 352 President Rules – Article 356 - Financial Emergency – Article 360Prime Minister and Cabinet - Supreme Court of India (Indian Judiciary)

UNIT – V

Indian Federalism: Union – State relations; - Legislative, Administrative and Financial relations. LokSabha, RajyaSabha, VidhanSabha & VidhanParishad - Composition; Speaker, Chairman, Privileges, Legislative procedure.

UNIT – VI

Parliamentary Committees: Public Accounts Committee - Estimates Committee - Committee on Public Undertakings. - Election commission of India (Article -324) - Comptrollar and Auditor General (CAG) of India (Article – 148 to 150) - Finance Commission (Article – 280) - NeethiAayog (Planning Commission) and - Political Parties.

TEXT BOOKS:

1. D.D Basu – Indian Constitution.
2. Dr. D. Surannaidu – Indian PoliticalSystem.
3. MadhavKhosla – The IndianConstitution.

REFERENCE BOOKS:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.

M. Tech., I Semester

PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS
(Audit Course – I)

SUBJECT CODE: 22MAC1004

L	T	P	C
2	0	0	0

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. Realize that everyone is responsible for creating his/her own personality.

CO 2. Gain knowledge of the importance of developing virtues like wisdom and courage and knowing what are good acts (do's) and bad acts (don'ts).

CO 3. Understand the key message of Bhagavad Gita which is experiencing spiritual oneness by practicing any or all of the karma, bhakti, dhyana or raja, and jnana yogas.

CO 4. Know the vedantic perspective of life with regards to understanding human nature, art of living and technique of self-unfoldment.

CO 5. Realize the goal and means to attain self-realization which is the only way to attain liberation.

CO 6. Become aware that sub-conscious mind which is full of desires is the main obstacle for self-realization and spiritual practices help in eliminating these desires.

UNIT-I

Personality Development: It is personality that matters – Laws of personality development – Different layers of personality – Pleasure is not the goal – How to change our character – Control your negative emotions – Change yourself first – Take whole responsibility of yourself.

UNIT-II

Holistic Personality Development: (from Bhartruhari Neeti Satakam)

Wisdom (Verses 19, 20, 21, 22) – Pride & Heroism (Verses 29, 31, 32) – Virtues (Verses 26, 28, 63, 65) – Don'ts (Verses 52, 53, 59) – Do's (Verses 71, 73, 75, 78)

UNIT-III

Bhagavad Gita:

Chapter 2 – Verses 17, 56, 62, 68
Chapter 3 – Verses 13, 21, 27, 35, 36, 37, 42
Chapter 4 – Verses 18, 38, 39
Chapter 6 – Verses 5, 13, 17, 23, 35
Chapter 12 – Verses 13, 14, 15, 16, 17, 18
Chapter 18 – Verses 37, 38, 45, 46, 48, 63

UNIT-IV

Vedantic Perspective of Life: Brief discussion of major topics in

Understanding human nature – Art of Living – Technique of self unfoldment

UNIT-V

Vivekachudamani: Self-realization is the means of liberation – Means to self-realization – Qualifications of a spiritual aspirant – 4-fold spiritual discipline

UNIT-VI

Mind and Its Mysteries: What is Mind? Mind and body, Mind and food – Mental faculties – Theory of perception, Memory, Imagination, Thought-Culture, Desires – Cultivation of virtues, Control of senses and mind – Concentration, Meditation and Enlightenment.

TEXT BOOKS:

1. Personality Development, Swami Vivekananda, Advaita Ashrama Publication, ISBN 978817552246
2. Three Satakam of Bharatrhari (Niti, Srngara, Vairagya), P. Gopinath, Rashtriya Sanskrit SansthanPubllication.
4. Bhagavad Gita, Swami Swarupananda, Advaita Ashram Publication.
5. Vedanta – Science of Life, 3 Vols, Swami Chinmayananda, Chinmaya Mission Pub (Vol1 – Understanding Human Nature, Vol2 – Art of Living, Vol3 – Technique of Self-Unfoldment)
6. Message of Vivekachudamani, Swami Ranganadhananda, Advaita Ashrama Publication, ISBN 817553089
7. Mind, Its Mysteries and Control, Swami Sivananda, Divine Life Society Publication.

REFERENCE BOOKS:

1. https://archive.org/download/satakasofbhartri00bharuoft/satakasofbhartri00bharuoft.pdf
2. Bhagavad Gita – Sadhaka Sanjivani, Swami Ramsukhdas, Gita Press Publication (1080, 1081)
3. The Goal and The Way, Swami Satprakashananda, Ramakrishna Math Publication
4. Spiritual Quest, Swami Tapasyananda, Ramakrishna Math Publications, ISBN 8171204562
5. Mind According to Vedanta, Swami Satprakashanada, Ramakrishna Math Publication, ISBN 8171206506

M. Tech., II Semester

ADVANCED HEAT TRANSFER

SUBJECT CODE: 22MTE1007

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. Understanding the different modes of heat transfer and their mathematical forms
CO 2. Apply the principles of heat transfer in the analysis of steady and transient conduction problems.
CO 3. Formulate and solve convective heat transfer and fluid mechanics problems for external flows.
CO 4. Formulate and solve convective heat transfer and fluid mechanics problems for internal flows.
CO 5. Understanding and analysis of free convection, boiling and condensation.
CO 6. Apply the concepts of radiation heat transfer for enclosure analysis.

UNIT - I

Brief Introduction to different modes of heat transfer; Conduction: General heat conduction equation- Initial and Boundary conditions

Steady State Heat Transfer: Simplified heat transfer in 1D and 2D – Fins

UNIT - II

Transient heat conduction; Lumped system analysis- Heisler's charts - semi infinite solid - use of shape factors in conduction - 2D transient heat conduction – Problem solutions

Forced Convection: Equations of fluid flow – Concepts of continuity, momentum equations – Derivation of energy equation – Dimensional analysis

UNIT - III

External flows: Flow over a flat plate: Critical Reynolds Number - Methods to determine heat transfer coefficient: Analogy between heat and momentum transfer - Analytical methods - Exact and Integral methods – Integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to various geometries for Laminar and Turbulent flows.

UNIT - IV

Internal flows: Fully developed flow: Laminar heat transfer coefficient for constant wall temperature and constant heat flux boundary conditions - Hydrodynamic and thermal entry lengths; use of empirical correlations. Reynolds – Colburn analogy - Application of empirical relations to various geometries for Laminar and Turbulent flows.

UNIT - V

Free convection: Integral analysis on laminar free convective heat transfer – Different geometries – combined free and forced convection

Boiling and condensation: Pool boiling–Boiling regimes - Correlations. Nusselt's theory of film condensation on a vertical plate – Assumptions and correlations of film condensation for different geometrics.

UNIT - VI

Radiation Heat Transfer: Radiant heat exchange in grey, Non-grey bodies, with transmitting, reflecting and absorbing media, Specular surfaces, Gas radiation – Radiation from flames.

TEXT BOOKS:

1. J.P. Holman, "Heat Transfer", McGraw Hill Book Company, New York, 1990.
2. Incropera and Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, NewYork, 2000.
3. Frank Kreith, "Principles of Heat Transfer", Harper and Row Publishers, New York, 1973.
4. Donald Q. Kern "Process Heat Transfer", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1975.

REFERENCES BOOKS:

1. Gupta and Prakash, "Engineering Heat Transfer", New Chand and Bros, Roorkee (U.P.) India, 1996.
2. R.C. Sachdeva "Fundamentals of Engineering Heat and Mass Transfer", Wiley Eastern Ltd., India,

M. Tech., II Semester

COMPUTATIONAL FLUID DYNAMICS

SUBJECT CODE: 22MTE1008

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

CO 1. Compare FD, FE, FV methods. Classify partial differential equations. Solve system of linear algebraic equations using direct and iterative approaches.

CO 2. Solve steady state and unsteady heat transfer problems using both explicit and implicit finite difference methods like Crank-Nicholson and ADI-ADE.

CO 3. Derive the basic rules for control volume approach using 1D steady heat conduction equation. Extend this to 2D & 3D steady and unsteady heat conduction problems.

CO 4. Apply finite volume method to problems containing both convection and diffusion. Assess various discretization schemes and treatment of boundary conditions.

CO 5. Formulate governing equations using stream function-vorticity method. Solve pressure-velocity coupled problems using SIMPLE and SIMPLER algorithms.

CO 6. Solve turbulent flows including direct numerical simulation, large eddy simulation, RANS models. Understand pressure-velocity-density coupling in compressible flows.

UNIT-I

Introduction to Numerical Methods - Finite difference, Finite element and finite volume methods – Classification of partial differential equations – Solution of linear algebraic equations – Direct and Iterative approache

UNIT-II

Finite Difference Methods: Taylor's series – FDE formulation for 1D and 2D steady state heat transfer problems – Boundary conditions – Unsteady state heat conduction – Errors associated with FDE - Explicit method – Stability criteria – Implicit method – Crank - Nickolson method – 2-D FDE formulation – ADI – ADE

UNIT - III

Finite Volume Method: Formation of basic rules for control volume approach using 1D steady heat conduction equation – Interface thermal conductivity - Extension of general nodal equation to 2D and 3D Steady heat conduction and Unsteady heat conduction

UNIT-IV

FVM to Convection and Diffusion: Concept of elliptic, Parabolic and Hyperbolic equations applied to fluid flow – Governing equations of flow and heat transfer – Steady 1D convection diffusion – Discretization schemes and their assessment – Treatment of boundary conditions

UNIT-V

Calculation of Flow Field: Vorticity & Stream function method - Staggered grid as remedy for representation of flow field - Pressure and Velocity corrections – Pressure velocity coupling - SIMPLE & SIMPLER (revised algorithm) Algorithm.

UNIT-VI:
Turbulent Flows: Direct numerical simulation, large eddy simulation and RANS Models
Compressible Flows: Introduction - Pressure, Velocity and Density Coupling.

TEXT BOOKS:

1. Computational Fluid Flow and Heat Transfer – Muralidharan & Sundarajan (Narosa Pub)
2. Numerical heat transfer and fluid flow – S.V. Patankar (Hemisphere Pub. House)
3. An Introduction to Computational Fluid Dynamics – FVM Method – H.K. Versteeg, W. Malalasekhara (PHI)
4. Computational Methods for Fluid Dynamics – Ferziger, Peric (Springer)
5. Computational Fluid Dynamics, The Basic with applications by John A. Anderson, Jr., McGraw Hill International editions, Mechanical Engineering series.

REFERENCE BOOKS:

1. Computational Fluid Dynamics, T.J. Chung, Cambridge University
2. Computaional Fluid Dynamics – A Practical Approach – Tu, Yeoh, Liu (Elsevier) Text Book of Fluid Dynamics, Frank Chorlton, CBS Publishers
3. An Introduction to Computational Fluid Mechanics by Chuen-Yen Chow, Wiley Publication.
4. Computational Fluid Flow & Heat Transfer by Murlidhar and Sundarrajan, Narosa Publication.

M. Tech., II Semester

THERMAL AND NUCLEAR POWER PLANTS
(Elective - III)

SUBJECT CODE: 22MTE1009

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

CO 1. Perform volumetric, gravimetric and flue gas analysis on combustion of coal.
CO 2. Understand working of a steam power plant including subsystems like fuel handling, boilers, ash handling, cooling towers, turbines and condensers.
CO 3. Perform thermal analysis of combined cycle gas turbine power plant including cogeneration, waste heat recovery, fluidized bed combustion and IGCC power plants.
CO 4. Describe methods of enriching uranium, applications, safety, economics and future of nuclear power plants.
CO 5. Perform economics of power generation including load factor, utilization factor, economic load sharing, depreciation, specific economic energy.
CO 6. Describe various pressure, temperature and flow measuring instruments. Analyze combustion gases for pollutants.

UNIT –I

Introduction – Sources of Energy, types of Power Plants, Direct Energy Conversion System, Energy Sources in India, Recent developments in Power Generation. Combustion of Coal, Volumetric Analysis, Gravimetric Analysis, Flue gas Analysis.

UNIT –II

Steam Power Plants: Introduction – General layout of steam power plant, Modern Coal- fired steam power plants, Power plant cycles, Fuel handling, Combustion equipment, Ash handling, Dust collectors.

Steam Generators: Types, Accessories, Feed water heaters, Performance of Boilers, Water Treatment, Cooling Towers, Steam Turbines, Compounding of Turbines, Steam Condensers, Jet & Surface Condensers.

UNIT - III

Gas Turbine Power Plant: Cogeneration, Combined cycle power plants, Analysis, Waste-Heat Recovery, IGCC power plants, Fluidized bed combustion – Advantages & Disadvantages.

UNIT -IV

Nuclear Power Plants: Nuclear Physics, Nuclear Reactors, Classification – Types of Reactors, Site Selection, Methods of enriching Uranium, Applications of Nuclear Power Plants.

Nuclear Power Plants Safety: By-Products of Nuclear Power Generation, Economics of Nuclear Power Plants, Nuclear Power Plants in India, Future of Nuclear Power.

UNIT -V

Economics of Power Generation: Factors affecting the economics, Load Factor, Utilization factor, Performance and Operating Characteristics of Power Plants. Economic Load Sharing, Depreciation, Energy Rates, Criteria for Optimum Loading, Specific Economic energy problems.

UNIT - VI

Power Plant Instrumentation: Classification, Pressure measuring instruments, Temperature measurement and Flow measurement. Analysis of Combustion gases, Pollution-Types, Methods to Control.

TEXT BOOKS:

1. Power Plant Engineering / P.K. Nag / TMH.
2. Power Plant Engineering / R.K. Rajput / Lakshmi Publications.

REFERENCEBOOKS:

1. Power Plant Engineering / P.C.Sharma / Kotaria Publications.
2. Power Plant Technology / Wakil.
3. Power Plant Engineering by Domkundwar.

M. Tech., II Semester

EXPERIMENTAL METHODS IN THERMAL ENGINEERING
(Elective - III)

SUBJECT CODE: 22MTE1010

L	T	P	C
3	0	0	3

COURSE OUTCOMES:
At the end of the course, student will be able to
CO 1. Identify the suitable instrument for measuring transport parameters and estimate error
CO 2. Detect suitable range of pressure gauge and compute its dynamic response
CO 3. Distinguish different flow visualization methods and temperature measurements.
CO 4. Determine thermal conductivity in solids, liquids and gases.
CO 5. Detect and measure thermal radiation and emissivity.
CO 6. Develop transfer function of given mechanical system by using concept of control system.

UNIT-I : Instrument classification, Static and Dynamic characteristics of instruments, Experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Reliability of instruments, Variable resistance transducers, Capacitive transducers, Piezoelectric transducers, Photoconductive transducers, Photovoltaic cells, Ionization transducers, Hall effect transducers.

UNIT-II: Dynamic response considerations, Bridgman gauge, McLeod gauge, Pirani thermal conductivity gauge, Knudsen gauge, Alphatron.

UNIT-III: Flow measurement by drag effects; Hot-wire anemometers, Magnetic flow meters, Flow visualization methods, Interferometer, Laser Doppler anemometer. Temperature measurement by mechanical effect, Temperature measurement by radiation, Transient response of thermal systems, Thermocouple compensation, Temperature measurements in high- speed flow.

UNIT-IV: Thermal conductivity measurement of solids, Liquids, and gases, Measurement of gas diffusion, Convection heat transfer measurements, Humidity measurements, Heat-flux meters.

UNIT-V: Detection of thermal radiation, Measurement of emissivity, Reflectivity and transmissivity, Solar radiation measurement.

UNIT-VI: Review of open and closed loop control systems and servo mechanisms, Transfer functions of Mechanical Systems, Input and output systems.

TEXT BOOK:
Holman, J.P., "Experimental methods for engineers", Tata McGrawHill, 7th Edition, 2007.

REFERENCES:
1. Prebrashensky V., "Measurement and Instrumentation in Heat Engineering", Vol.1, MIR Publishers, 1980.
2. Raman C.S. Sharma G.R., Mani V.S.V., "Instrumentation Devices and Systems", 2nd Edition, Tata McGraw-Hill., 2001.
3. Morris A.S, "Principles of Measurements and Instrumentation", 3 rd Edition, Butterworth-Heinemann, 2001.

M. Tech., II Semester

IC ENGINES AND COMBUSTION

SUBJECT CODE: 22MTE1011

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. Analyze air standard, fuel air and actual air cycles in terms of various losses. Understand construction, working and mechanism of engine subsystems.

CO 2. Describe combustion processes occurring in SI engines. Identify the factors affecting flame speed, ignition lag, flame propagation and knocking.

CO 3. Describe processes of combustion in CI engine and effect of various parameters. Explain diesel knock reduction methods like swirl and auto-ignition.

CO 4. Calculate engine performance using various parameters and heat balance sheet.

CO 5. Describe different types of emission norms.

CO 6. Understand types of alternate fuels and its advantages over conventional fuels.

UNIT - I

Classification: Classification based on fuel, Working cycle, Method of fuel supply. Ignition and Governing. Scavenging of two stroke engines. Fuel – air cycles & actual air cycles and their analysis.

UNIT - II

Spark Ignition Engines: Flame speed-effect of turbulence and other parameters. Normal and abnormal combustion. Auto ignition and Pre ignition. Fuel requirements, Knock ratings, Combustion chambers. Carburetion-mixture strength requirements. Simple carburettor - limitations, Compensating arrangements. Gasoline injection systems.

UNIT - III

Compression Ignition Systems: Low and high speed types. Air utilization and output. Combustion process-Ignition delay. Knocking and effect of variables. Fuel requirements and rating. Combustion chambers. Fuel injection systems.

Super Charging: Types of engine supercharging. Engine supercharging devices. Turbo charging.

UNIT-IV

Performance of IC Engines: Measurement of engine power, Analysis of engine performance. Factors effecting efficiency and power, Heat loss, Pumping loss, Geometry, Speed, Air/Fuel ratio. Heat balance test. BIS standards for testing and rating. Modern Developments: Wankel engine. Stratified charge engine. Dual-fuel engines. HCCI concept.

UNIT - V

Engine Emissions: SI and CI engine emissions. Harmful effects. Emissions measurement methods. Methods for controlling emissions. EURO and BHARAT emission norms.

UNIT - VI

Alternate Fuels For IC Engines: Need for use of alternate fuels. Use of alcohol fuels. Biodiesel. Biogas and Hydrogen in engines.

TEXT BOOKS:

1. Ganesan,V., Internal Combustion Engines, Tata McGraw Hill Publishing Company, 2007.
2. Mathur, M.L., and Sharma, R.P., A Course in Internal Combustion Engines, Dhanpat Rai and Sons, 2008.

REFERENCE BOOKS:

1. John, B.H., Internal Combustion Engine Fundamentals, McGraw Hill, 1988.
2. IC engines by Mathur and Sharma
3. Advance Engineering Thermodynamics by Holmans..

M. Tech., II Semester

JET PROPULSION AND ROCKETRY

SUBJECT CODE: 22MTE1012

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Given the basic geometry and idealized component performance, to be able to estimate the thrust and specific impulse of a gas turbine and a rocket engine from fluid and thermodynamic principles.

COURSE OUTCOMES:

CO 1: Perform gas turbine cycle thermodynamic analysis including on compressors and turbines, blade aerodynamics.

CO 2: Understand fundamentals of jet propulsion, and classify them into turbojet, turbofan, turboprop, rocket, ramjet engines.

CO 3: Conduct performance analysis on subsonic and supersonic nozzles.

CO4 : Explain aero-thermo chemistry of combustion products. Describe composition and manufacturing methods of solid propellants.

CO 5: Perform design calculations for solid rocket motor design. Design injectors, propellant tank, pump and pressure feed systems, combustion chamber that uses liquid propellants.

CO 6: Design ramjet and integral rocket ramjet propulsion system for critical, super-critical and sub-critical operation of air intake.

UNIT-I

Turbo Jet Propulsion System:

Gas turbine cycle analysis – layout of turbo jet engine. Turbo machinery- compressors and turbines, combustor, blade aerodynamics, engine off design performance analysis

Flight Performance:

Forces acting on vehicle – Basic relations of motion – multi stage vehicles.

UNIT-II

Principles of Jet Propulsion and Rocketry:

Fundamentals of jet propulsion, Rockets and air breathing jet engines – Classification – turbo jet , turbo fan, turbo prop, rocket (Solid and Liquid propellant rockets) and Ramjet engines.

UNIT-III

Nozzle Theory and Characteristics Parameters:

Theory of one dimensional convergent – divergent nozzles – aerodynamic choking of nozzles and mass flow through a nozzle – nozzle exhaust velocity – thrust, thrust coefficient, A_C / A_t of a nozzle, Supersonic nozzle shape, non-adapted nozzles, summer field criteria, departure from simple analysis – characteristic parameters – 1) characteristic velocity, 2) specific impulse 3) total impulse 4) relationship between the characteristic parameters 5) nozzle efficiency, combustion efficiency and overall efficiency.

UNIT-IV

Aero Thermo Chemistry of the Combustion Products:

Review of properties of mixture of gases – Gibbs – Dalton laws – Equivalent ratio, enthalpy changes in reactions, heat of reaction and heat of formation – calculation of adiabatic flame temperature and specific impulse – frozen and equilibrium flows.

Solid Propulsion System:
Solid propellants – classification, homogeneous and heterogeneous propellants, double base propellant compositions and manufacturing methods. Composite propellant oxidizers and binders. Effect of binder on propellant properties. Burning rate and burning rate laws, factors influencing the burning rate, methods of determining burning rates.

UNIT-V
Solid propellant rocket engine: internal ballistics, equilibrium motor operation and equilibrium pressure to various parameters. Transient and pseudo equilibrium operation, end burning and burning grains, grain design. Rocket motor hard ware design
Liquid Rocket Propulsion System:
Liquid propellants – classification, Mono and Bi propellants, Cryogenic and storage propellants, ignition delay of hypergolic propellants, physical and chemical characteristics of liquid propellant. Liquid propellant rocket engine – system layout, pump and pressure feed systems, feed system components.

UNIT-VI
Ramjet and Integral Rocket Ramjet Propulsion System:
Fuel rich solid propellants, gross thrust, gross thrust coefficient, combustion efficiency of ramjet engine, air intakes and their classification – critical, super critical and sub-critical operation of air intakes, engine intake matching, classification and comparison of IIRR propulsion systems.

TEXT BOOKS:
1. Mechanics and Dynamics of Propulsion – Hill and Peterson
2. Rocket propulsion elements – Sutton

REFERENCE BOOKS:
1. Gas Turbines – Ganesan (TMH)
2. Gas Turbines & Propulsive Systems – Khajuria & Dubey (Dhanpatrai)
3. Rocket propulsion – Bevere
4. Jet propulsion – Nicholas Cumpsty

M. Tech., II Semester

DESIGN OF SOLAR AND WIND SYSTEM
(Elective - V)

SUBJECT CODE: 22MTE1013

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

CO 1. Analyze energy demand and energy resources of the world and nation. Understand the amount of solar radiation received by earth.
CO 2. Estimate average solar radiation on horizontal and titled surfaces.
CO 3. Conduct performance analysis on liquid flat plate collectors without and with plane reflectors, cylindrical parabolic collectors with orientation and tracking.
CO 4. Describe the principle, construction and applications of solar cells for direct energy conversion.
CO 5. Compute characteristics of wind energy conversion systems using various coefficients.
CO 6. Describe fuel cells, photo-voltaic cells, Discuss bioenergy generation including bio-conversion processes, bio-gas plant technology, biomass gasification and economics of biomass systems.

UNIT - I

Introduction – **Introduction** – Energy Scenario - Survey of energy resources – Classification – Need for conventional and Non-Conventional energy resources. Solar radiation, Beam and diffuse radiation. The Sun-Earth Relationship —Alternative energy sources.

UNIT - II

Radiation measuring instruments. Estimation of average solar radiation on horizontal and tilted surfaces – Problems – Applications; Physical principles of collection – types – Solar energy utilization. The Sun-Earth Relationship.

UNIT - III

Capturing solar radiation – Physical principles of collection – Types – Liquid flat plate collectors – Construction details – Performance analysis – Concentrating collection – Flat plate collectors with plane reflectors – Cylindrical parabolic collectors – Orientation and tracking – Performance Analysis. Thermal energy storage.

UNIT - IV

Direct energy conversion – Solid-state principles – Semiconductors – Solar cells – Performance – Modular construction – Applications. Photovoltaic cells –Thermionic and Thermoelectric Generation – MHD Generator.

UNIT - V

Wind Energy: Wind – Beaufort number – characteristics – Wind energy conversion systems – Types – Betz model – Interference Factor – Power Coefficient – Torque Coefficient and thrust coeff.- Lift machines and drag machines – Matching – Electricity generation. Energy from Oceans

UNIT – VI

Fuel Cell s–Thermionic and Thermoelectric Generation. , Biomass, biogas, hydrogen, geothermal energy.

TEXT BOOKS:

1. Principles of solar engineering – Kreith and Kerider
2. Solar energy thermal processes – Duffie and Beckman
3. Solar energy – Sukhatme

REFERENCE BOOKS:

1. D.Y. Goswami, F. Kreith and J.F. Kreider, "Principle of Solar Engineering", Taylor and Francis, 2000.
2. Sukhatme S.P., "Solar Energy", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
3. Bansal and othes, "Non-Conventional Energy Sources".
4. J.F. Kreider, F. Kreith, "Solar Energy Handbook", McGraw Hill, 1981
5. J.A. Duffie and W.A. Beckman, "Solar Engineering of Thermal Processes", John Wiley, 1991.

M. Tech., II Semester

ENERGY CONSERVATION AND MANAGEMENT
(Elective - V)

SUBJECT CODE: 22MTE104

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

CO 1. Understand the principles of energy management and the role of energy manager in various organizations.
CO 2. Understand types of energy audits. Gather and analyze relevant data.
CO 3. Perform economic analysis including depreciation, risk analysis and budget considerations.
CO 4. Describe technologies for energy conservation. Assess critically energy usage using energy flow networks, optimization and technical analysis of options.
CO 5. Know common methods of evaluation of projects.
CO 6. Understand the need for energy consultant and his selection criteria.

UNIT - I

Introduction: Principles of energy management – Managerial organization – Functional areas for **i.** manufacturing industry **ii.** Process industry **iii.** Commerce **iv.** Government. Role of Energy Manager in each of these organization. Initiating, Organising and Managing energy management programs

UNIT - II

Energy Audit: Definition and Concepts, Types of energy audits – Basic energy concepts – Resources for plant energy studies – Data gathering – Analytical techniques.

UNIT - III

Economic Analysis: Scope, Characterization of an Investment project-Types of Depreciation – Time value of money – Budget considerations, Risk Analysis

UNIT - IV

Energy Conservation: Technologies for energy conservation , Design for Conservation of energy materials – Energy flow networks – Critical assessment of energy usage – Formulation of objectives and constraints – Synthesis of alternative options and technical analysis of options – Process integration.

UNIT - V

Methods of Evaluation of Projects: Payback – Annualised costs – Investor's rate of return – Present worth – Internal rate of return – Pros and Cons of the common methods of analysis – Replacement analysis.

UNIT - VI

Energy Consultant: Need of Energy Consultant – Consultant Selection Criteria. Energy conservation in industries, Cogeneration, Combined heating and power systems,

TEXT BOOKS:

1. Energy Management Hand book by W.C. Turner (Ed)
2. Management by H.Koontz and Cyrill O Donnell

REFERENCE BOOKS:

1. L.C. Witte, P.S. Schmidt, D.R.Brown, "Industrial Energy Management and Utilization", Hemispherical Publication, 1988.
2. Callaghan "Energy Conservation".
3. D.A. Reeg, "Industrial Energy Conservation", Pergamon Press, 1980.
4. T.L. Boyen, "Thermal Energy Recovery" Wiley, 1980.
5. L.J. Nagrath, "Systems Modeling and Analysis", Tata McGraw Hill, 1982.
6. I.G.C. Dryden, "The Efficient Use of Energy ", Butterworth, London, 1982.
7. R. Loftnen, Van Nostrarid Reinhold C. "Energy Handbook", 1978. 9. TERI Publications.

M. Tech., II Semester

INDUSTRIAL SAFETY
(Open Elective)

SUBJECT CODE: 22MOE1001

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

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

CO 1. Understand the types, causes and preventive steps of mechanical and electrical hazards.

CO 2. Identify types of maintenance and apply relevant tools of maintenance.

CO 3. Understand the types, causes, applications of wear and types and prevention methods of corrosion

CO 4. Understand the concepts of fault tracing and decision tree for different machine tools

CO 5. List the applications of periodic maintenance.

CO 6. Illustrate the applications of preventive maintenance.

UNIT – I

Industrial safety

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

UNIT – II

Fundamentals of maintenance engineering

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

UNIT – III

Wear and Corrosion and their prevention

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT – IV

Fault tracing

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT – V

Periodic and preventive maintenance

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance.

UNIT – VI

Procedure for periodic and preventive maintenance

Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TEXT BOOKS:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

REFERENCE BOOKS:

1. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
2. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

M. Tech., II Semester

OPERATIONS RESEARCH
(Open Elective)

SUBJECT CODE: 22MOE1002

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. Formulate, solve linear programming problem using graphical and simplex method along with its Big-M and 2-Phase variations.
CO 2. Solve both balanced and unbalanced transportation and assignment problems.
CO 3. Apply the concept of non-linear programming
CO 4. Compute queue performance characteristics for various queuing models.
CO 5. Solve game theory problems by applying standard solution methods.
CO 6. Calculate critical path for a given network using PERT and CPM techniques.

UNIT-I

Linear Programming: Introduction to linear programming problem formulation, Graphical solution, Simplex method, Artificial variables techniques, Degeneracy.

UNIT-II

Transportation Problem: Formulation, Optimal solution, unbalanced transportation problems, Degeneracy.

Assignment Problem: Formulation, Optimal solution, Traveling salesman problem.

UNIT-III

Nonlinear Programming Problems: Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem.

UNIT-IV

Queuing Theory: Characteristics of Queuing models, Classification, (M/M/1):(FCFS/∞/∞), (M/M/1):(FCFS/N/∞), (M/M/C):(FCFS/∞/∞) models.

UNIT-V

Theory of Games: Introduction, Two-person Zero-sum games, Maximum-Minimax principle, Games without saddle points, Mixed Strategies, m × 2 & 2 × n games, Graphical solutions, Dominance property, Algebraic solutions to rectangular games.

UNIT-VI

Network models: Project network, CPM and PERT, Critical path scheduling, Cost considerations in project scheduling.

TEXT BOOKS:

1. Introduction to Operations Research by Prem Kumar Gupta, D.S. Hira, S. Chand Publishers
2. Operations Research, S.D.Sharma, Kedarnath Ramanadh Pub.

REFERENCES BOOKS:

1. Operations Research, J.K. Sharma, MacMilan Pub.
2. Operations Research by P. Rama Murthy, New Age Pub.
3. CPM & PERT, L.S. Srinath, Affiliated East West Press Pu

M. Tech., II Semester

COMPOSITE MATERIALS
(Open Elective)

SUBJECT CODE: 22MOE1003

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

On completion of this course, students will be able to

CO 1. Illustrate the concept and classification of composites.

CO 2. Understand fundamental fabrication processes for polymer matrix.

CO 3. Analyze and understanding the properties & processing of different metal matrix composites

CO 4. Understand the fundamental concepts of ceramic matrix composites.

CO 5. Understand and Predict elastic properties of long fiber and short fiber composites.

CO 6. Design different types of composite by apply the micromechanics principles.

UNIT - I

Introduction: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT - II

Reinforcements and the reinforcement matrix interface: Natural fibers; Synthetic organic fibers – aramid, polyethylene; and Synthetic inorganic fibers – glass, alumina, boron, carbon, silicon based fibers; Particulate and whisker reinforcements, Reinforcement-matrix interface – Wettability, Interfacial bonding, and methods for measuring bond strength.

UNIT - III

Metal Matrix Composites: Introduction, Important metallic matrices and properties; Metal matrix composite processing: Solid state processing – Diffusion bonding, Powder metallurgy; liquid state processing – Melt stirring, Compocasting, Squeeze casting, Liquid infiltration under gas pressure; Deposition – spray co-deposition and other deposition techniques like CVD and PVD; in situ processes. Interface reactions.

UNIT - IV

Ceramic Matrix Composites: Introduction; processing and structure of monolithic materials – technical ceramics, glass-ceramics. Processing of ceramics: conventional mixing and pressing – cold pressing and sintering, hot pressing, reaction bonding processes, techniques involving slurries, liquid state processing – matrix transfer moulding, liquid infiltration, sol-gel processing, lanxide process and in situ processes. Processing, properties and applications of alumina matrix composites - SiC whisker reinforced, zirconia toughened alumina; Carbon-carbon composites

UNIT - V

Polymer Matrix Composites: Introduction; polymer matrices – thermosetting, thermoplastic, rubbers. Processing of PMCs , Processing, properties and applications of fibre-reinforced epoxies, PEEK matrix composites, rubber matrix composites. Damping characteristics. Environmental effects in polymer matrix composites. Recycling of PMCs.

UNIT - VI

Micromechanics of unidirectional composites: micromechanics models for stiffness – longitudinal stiffness, transverse stiffness, shear modulus, Poisson's ratio.

TEXT BOOKS:

1. Composite Materials: Engineering and Science, by Matthews and Rawlings, CRC Press.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

REFERENCES BOOKS:

1. Composite Materials Science and Engineering, K.K.Chawla, Springer.
2. An Introduction to composite material, by D.Hull and T.W. Clyne, Cambridge University press.
3. Metal Matrix Composites, Thermomechanical Behaviour by M.Taya, and R.J.Arsenault, Pergamon Press, Oxford.
4. Fundamentals of Metal Matrix Composites by S.Suresh, A.Martensen, and A.Needleman, Butterworth, Heinemann
5. Engineering Materials and Their Applications – R. A Flinn and P K Trojan / Jaico Books.

M. Tech., II Semester

WASTE TO ENERGY
(Open Elective)

SUBJECT CODE: 22MOE1004

L	T	P	C
3	0	0	3

COURSE OUTCOMES:

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

CO 1. Diagnosis the different wastes and their conversion devices.
CO 2. Assess the diverse pyrolysis types of biomass and production methods of different fuel oils.
CO 3. Evaluate the gasification methods of biomass, their design, construction and operation.
CO 4. Suggest the combustion processes of biomass, their design, construction and operation.
CO 5. Analyze the types of biogas plants.
CO 6. Design and develop the biomass conversion processes.

UNIT – I

Introduction to Energy from Waste: Classification and Characterization of waste as fuel – Agro based, Forest residue, Industrial waste – Municipal Solid Waste Conversion devices – Incinerators, gasifiers, digesters.

UNIT – II

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods -Yields and application – Manufacture of pyrolytic oils and gases, yields and applications- Oil from waste plastics - Alcohol production from biomass - Bio diesel production.

UNIT – III

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT – IV

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs,fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT – V

Biogas: Properties of biogas (Calorific value and composition) - Types of biogas Plants – Applications - Technologyand status of Biogas plants - Bio energy system - Design and constructional features - Biomass energy program in India.

UNIT – VI

Biomass: Biomass resources and their classification - Biomass conversion processes – Thermo-chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Urban waste to energy conversion.

TEXT BOOKS :

1. Rogoff, M.J. and Screve, F., "Waste-to-Energy: Technologies and Project Implementation", Elsevier Store - Reprint - 2011.
2. Hall, D.O. and Overeed, R.P.," Biomass - Renewable Energy", John Willy and Sons – Reprint - 1987.
3. Harker, J.H. and Backhusrt, J.R., "Fuel and Energy", Academic Press Inc – Reprint - 1981.
4. EL-Halwagi, M.M., "Biogas Technology- Transfer and Diffusion", Elsevier Applied Science – Reprint - 1984.

REFERENCES BOOKS:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
4. Mondal, P. and Dalai, A., “Utilization of natural resources”, CRC Press – Published – 2017.
5. Young G.C., "Municipal Solid Waste to Energy Conversion processes", John Wiley and Sons – Reprint – 2010.

M. Tech., II Semester

COMPUTATIONAL FLUID DYNAMICS LAB

SUBJECT CODE: 22MTE1103

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

CO 1. Formulate 1D problems in heat transfer.
CO 2. Develop codes for numerical methods to solve 2D heat conduction and convection problems.
CO 3. Use commercial software ANSYS for solving real life engineering problems.
CO 4. Modelling of flow around streamlined and Bluff bodies using commercial CFD solvers
CO 5. Simulation on natural and mixed convection problems, laminar/turbulent flows, forced convection problems using commercial CFD solvers.
CO 6. Exercises on hydrodynamic and thermal boundary layer problems using commercial CFD solvers.

LIST OF EXPERIMENTS:

1. Solution of 1D heat conduction problem using TDMA and LU decomposition.
2. Solution of 2D parabolic equations (a) Explicit (b) Implicit (ADI)
3. Grid generation (rectangular and circular)
4. Introduction to ANSYS FLUENT
   ANSYS FLUENT 1 (Laminar pipe Flow)
   ANSYS FLUENT 2 (Turbulent Pipe Flow)
5. Analysis of Flow in a Lid-Driven Cavity using FLUENT.
6. CFD Analysis of Flow in an Intake Manifold.
7. Analysis of Flow and Heat Transfer over a Flat Plate.
8. Simulation of Flow Development in a Pipe.
9. Analysis of Flow past a Circular Cylinder.
10. In viscid & Compressible Flow through a Converging-Diverging Nozzle.

REFERANCE BOOKS:

1. Versteeg, H. K. and Malalasekera, W., an Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd Edition, Pearson, 2010.
2. Tannehill, J. C., Anderson, D. A. and Pletcher, R. H., Computational Fluid Mechanics and Heat Transfer, McGraw Hill, 2002.
3. Blazek, J., Computational Fluid Dynamics: Principles and Applications, 2nd Edition, Elsevier Science & Technology, 2006.
4. Chung, T. J., Computational Fluid Dynamics, Cambridge University Press,2003.

M. Tech., II Semester

MINOR PROJECT

SUBJECT CODE: 22MTE1201

L	T	P	C
0	0	4	2

M. Tech., III Semester

TECHNICAL SEMINAR

SUBJECT CODE: 22MTE2202

L	T	P	C
0	0	4	2

M. Tech., III Semester

DISSERTATION PHASE - I

SUBJECT CODE: 22MTE2203

L	T	P	C
0	0	20	10

M. Tech., IV Semester

DISSERTATION PHASE - II

SUBJECT CODE: 22MTE2204

L	T	P	C
0	0	32	16