2017-2018

UNIVERSITY INSTITUTE OF ENGINEERING & TECHNOLOGY
(AICTE Approved)
KURUKSHETRA UNIVERSITY, KURUKSHETRA

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With Specialization in Thermal Engineering)
CREDIT BASED SYSTEM

SEMESTER-I	Subject	L	T	P	Total	Minor Test	Major Test	Cr.	Duration of Exam (hrs)
MTTH-901	Advanced Fluid Engineering	4	-	-	4	40	60	4	3
MTTH-903	Advanced Heat Transfer	4	-	-	4	40	60	4	3
MTTH-905	Advanced Refrigeration Engineering	4	-	-	4	40	60	4	3
MTTH-907	Design of Thermal Systems	4	-	-	4	40	60	4	3
MTME-809	Research Methodology and Optimization Techniques	4	-	-	4	40	60	4	3
MTTH-911	Advanced Heat Transfer Lab	-	-	2	2	40	60	1	-
					Total	**240**	**360**		
						600		**21**	

SEMESTER-II	Subject	L	T	P	Total	Minor Test	Major Test	Cr.	Duration of Exam (hrs)
MTTH-902	Computational Fluid Dynamics	4	-	-	4	40	60	4	3
MTTH-904	Advanced Internal Combustion Engines	4	-	-	4	40	60	4	3
MTTH-906	Finite Element Methods	4	-	-	4	40	60	4	3
MTTH-908	Solar Energy	4	-	-	4	40	60	4	3
	Elective-I	4	-	-	4	40	60	4	3
MTTH-910	Computational Fluid Dynamics Lab	-	-	2	2	40	60	1	-
					Total	**240**	**360**		
						600		**21**	

LIST OF ELECTIVE – I (Thermal Engg.) for 2nd Semester		
1.	MTTH-914	Advanced Thermodynamics
2.	MTTH-916	Renewable Energy & Energy Management
3.	MTTH-918	Convective Heat Transfer
4.	MTME-920	Measurements in Thermal Engineering
5.	MTTH-922	Design of Heat Transfer Equipments

SEMESTER-III	Subject	L	T	P	Total	Minor Test	Major Test	Cr.	Duration of Exam (hrs)
	Elective-II	4	-	-	4	40	60	4	3
	Elective-III	4	-	-	4	40	60	4	3
MTTH-913	Synopsis	-	-	-	-	100	-	10	-
					Total	**180**	**120**		
						300		**18**	

LIST OF ELECTIVE – II (Thermal Engg.) for 3rd Semester		
1.	MTTH-915	Air Conditioning
2.	MTTH-917	Cryogenic Engineering
3.	MTTH-919	Combustion Engineering
4.	MTTH-921	Nuclear Engineering
5.	MTTH-923	Jet and Rocket Propulsion

LIST OF ELECTIVE – III (Thermal Engg.) for 3rd Semester		
1.	MTTH-925	Thermal Modeling and Analysis
2.	MTTH-927	Numerical & Optimization Methods
3.	MTTH-929	Advanced Computational Fluid Dynamics
4.	MTME-931	Gas Dynamics
5.	MTTH-933	Compressible Flow Machines

SEMESTER-IV		L	T	P	Total	Minor Test	Major Test	Cr.	Duration of Exam (hrs)
MTTH-912	Dissertation	-	-	-	-	100	200	18	-
						100	**200**		
					Total	**300**		**18**	

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INSTRUCTIONS FOR PAPER SETTER

1. The question paper is to be attempted in **THREE Hours**.
2. Maximum Marks for the paper are **60.**
3. The syllabus for the course is divided into **FOUR units.**
4. The paper will have a total of **NINE questions.**
5. **Question No. 1,** which is compulsory, shall be OBJECTIVE Type **and have content from the entire syllabus (all Four Units).**

Q. No. 2 & 3	**from**	**Unit I**
Q. No. 4 & 5	**from**	**Unit II**
Q. No. 6 & 7	**from**	**Unit III**
Q. No. 8 & 9	**from**	**Unit IV**

6. All questions will have equal **weightage of 12 marks.**
7. The candidate will attempt a total of **FIVE questions**, each of 12 marks. Q. No. 1 is compulsory. The candidate shall attempt remaining **four** questions by selecting **only one question from each unit.**
8. A question may have any number of sections labeled as 1(a), 1(b), 1(c), 1(d), ---- 2(a), 2(b),-----. A section may further have any number of subsections labeled as (i), (ii), (iii),------.
9. **SPECIAL INSRUCTIONS FOR Q. No. 1 ONLY**

   Question No. 1, which is compulsory, shall be OBJECTIVE/ short answer type **and have content from the entire syllabus (all Four Units).**

   Emphasis is to be given on the basic concepts, analytical reasoning and understanding of the various topics in the subject. This question may have a number of parts and/or subparts. The short questions could be combination of following types:

   i. Multiple Choice
   ii. Yes/ No choice
   iii. Fill in Blanks type
   iv. Short numerical computations
   v. Short Definitions
   vi. Matching of Tables

The above mentioned question types is **only a Guideline**. Examiner could set the question as per the nature of the subject.

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First Semester

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Semester) (THERMAL ENGINEERING)

MTTH-901	ADVANCED FLUID ENGINEERING						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	To review the basic concepts of fluid mechanics and understand advance topics of compressible flow and vorticity.						
Course Outcomes							
CO 1	Develop and understand the basic governing equations of fluid flow in integral and differential form. Also to understand the kinematics of fluid flow.						
CO 2	Understanding of basic concepts of viscous flow and develop the exact solution of Navier Stokes equations. Also to understand the boundary layer flows.						
CO 3	Analyze the compressible flow and develop an understanding of normal and oblique shock waves.						
CO 4	Enable the students to understand the concepts of vorticity and related equations and theorems.						

UNIT-1

Review of basic concepts.

Basic equations of fluid flow: Reynold's transport theorem, continuity, momentum and energy equations in integral form and their applications, differential form of these equations, Navier Stokes equation, Euler's equation, Bernoulli's equation.

Ideal flow: Kinematics of fluid flow; potential flow; sources, sinks and vortices; superimposition of uniform stream with above, doublets; Rankine ovals; flow around uniform cylinders with and without circulation; pressure distribution on the surface of these bodies and D'Alembert's paradox.

UNIT-2

Exact solution of N-S equations: plane Poiselle and Coutte flows; Hagen-Poiselle flow through pipes; flows with very low Reynold's numbers; Stokes flow around a sphere; elements of hydrodynamic theory of lubrication.

Boundary layer flows: elements of two dimensional boundary layer theory; displacement thickness and momentum thickness; skin friction; Blasius solution for boundary layer on a flat plate; Karman-Pohlhausen integral method for obtaining approximate solutions, boundary layer separation & control, integral method for non-zero pressure gradient flows, entry flow into a duct, transition from laminar to turbulent flows, Reynold's stresses, turbulent boundary layer equation, turbulent pipe flow, Prandtl's mixing length hypothesis

UNIT-3

Compressible flow: speed of sound and Mach number, basic equations for one dimensional compressible flow, isentropic relation, propagation of infinitesimal and finite disturbances, stagnation and critical conditions, effect of variable flow area, converging and converging-diverging nozzles and diffusers, normal shock waves, basic equations for a normal shock wave, normal shock flow functions for one dimensional flow of an ideal gas, Supersonic channel flow with shocks, Fanno line and Rayleigh line flows, oblique shock waves, isentropic expansion waves, Prandtl Meyer expansion waves.

UNIT-4

Vortex motion: definitions; vortex lines; surfaces and tubes; vorticity; circulation; Kelvin's circulation theorem; Helmholtz's vorticity theorem; Biot-Savart law for induced vorticity; system of vortex filaments; horse-shoe vortex filaments; ring vortices; vortices streets; Karman vortex street.

Reference/Text Books:

1. Fundamentals of Mechanics of Fluid by I.G. Currie, Mcgraw-Hill
2. Foundation of Fluid Mechanics, Yuan, Prentice Hall.
3. Introduction to Fluid Mechanics, R.W. Fox, P.J. Pritchard & A.T. McDonald, Wiley India.
4. Introduction to Fluid Mechanics and Fluid Machines by S.K. Som and G. Biswas, TMH.
5. Fluid Mechanics and its applications, Gupta and Gupta, Willey Easter

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining* ***four*** *questions by selecting* ***only one question from each unit.***

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Semester) (THERMAL ENGINEERING)

MTTH-903	ADVANCED HEAT TRANSFER						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	To impart the in depth knowledge about the basic modes of heat transfer and learn advance topics of multi-dimensional heat conduction and mass transfer.						
Course Outcomes							
CO 1	Understand the basic concepts of steady and unsteady one dimensional and multidimensional heat conduction.						
CO 2	Differentiate and analyze the forced external, internal and natural convective heat transfer.						
CO 3	Understanding the heat transfer mechanism in boiling and condensation.						
CO 4	Classify different types of heat exchangers and gain knowledge about the various heat enhancement techniques.						
CO 5	Develop knowledge about the laws of radiation and analyze the radiative heat transfer between different surfaces.						
CO 6	Develop an understanding of the concept of mass transfer.						

UNIT-1

Conductive Heat Transfer: Review of the basic laws of conduction, convection and radiation. General heat conduction equation in different co-ordinates. One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat sources. Extended surfaces review, tapered fins, design considerations.
Two and three dimensional steady-state conduction, method of separation of variables, graphical method, relaxation technique.

Unsteady heat conduction: lumped capacitance method, validity of lumped capacitance method, general lumped capacitance analysis, spatial effects, plane wall with convection, radial systems with convection, semi-infinite solid, constant surface temperature and heat fluxes, periodic heating, solutions using Heisler's charts.

UNIT-2

Convective Heat Transfer: Introduction to convection boundary layers, local and average convection coefficients, laminar and turbulent flow, boundary layer equations, boundary layer similarity, boundary layer analogies – heat and mass transfer analogy, Reynold's and Colburn analogies.

Forced convection: external forced convection - empirical method, flat plate in parallel flow, cylinder in cross flow, flow over a sphere; internal forced convection – hydrodynamic and thermal considerations, energy balance, laminar flow in circular tubes, convection correlations.

Natural Convection: physical considerations, governing equations, laminar free convection on vertical surface, empirical correlations, free convection within parallel plate channels, empirical correlations, combined free and forced convection.

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UNIT-3

Heat Transfer with Phase Change: dimensionless parameters in boiling and condensation, boiling modes, pool boiling, correlations, forced convection boiling, physical mechanism of condensation, laminar and turbulent film condensation, film condensation in tubes, dropwise condensation.

Exchangers: Basic design methodologies – LMTD and effectiveness NTU methods, overall heat transfer coefficient, fouling of heat exchangers, classification of heat exchangers according to constructional features: tubular, plate type, extended surface heat exchanger, compact heat exchangers, design of double pipe heat exchangers, plate and heat pipe type, heat transfer enhancement - Passive and active techniques.

UNIT-4

Radiation Heat Transfer: Fundamental concepts, radiation intensity, irradiation, radiosity, black body radiation, Basic laws of radiation, emission from real surfaces, absorption, reflection and transmission by real surfaces, Kirchoff's law, Gray surface, radiative heat exchange between two or more surfaces, view factor, radiation exchange between opaque, diffuse, gray surface in an enclosure; net radiation exchange at a surface, radiation exchange between surfaces, blackbody radiation exchange, two-surface enclosure, radiation shields, multimode heat transfer, radiation exchange with participating media.

Mass Transfer: physical origins and rate equations, mixture composition, Fick's law of diffusion, mass transfer in stationary media, steady state diffusion through a plane membrane, equimolal diffusion, diffusion of water vapours through air, mass transfer coefficient, convective mass transfer, correlations.

Reference/Text Books:

1. Fundamentals of Heat and Mass Transfer by Incropera, Dewitt, Bergmann and Levine, Wiley India.
2. Heat Transfer by J.P. Holman, McGraw Hill.
3. Heat and Mass Transfer by Y.V.C. Rao, Universities Press.
4. Heat and Mass Transfer by D.S. Kumar, Katson Publication.
5. Principles of Heat Transfer by Kreith and Bohn, Thomson Learning.
6. Heat Exchangers Design and Theory by N.H. Afgan and Schliinder, MGH

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining **four** questions by selecting **only one question from each unit.***

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Semester)
(THERMAL ENGINEERING)

MTTH-905	ADVANCED REFRIGERATION ENGINEERING						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major test**	**Minor test**	**Total**	**Time (Hrs.)**
4	-	-	4	60	40	100	3
Purpose	**To impart knowledge about the various types of refrigeration systems.**						
Course Outcomes							
CO 1	**Acquire an overview of various common refrigeration systems.**						
CO 2	**Estimate the refrigeration load and design the system components.**						
CO 3	**Able to understand the simple refrigeration system and liquefaction of gases.**						
CO 4	**Develop the skills required to analyze the multi pressure refrigeration systems.**						

UNIT-1

Air Refrigeration System: Reverse Carnot cycle, most efficient refrigerator, Bell-Coleman cycle, advantages and disadvantages of air refrigeration system, necessity of cooling the aeroplanes, simple cooling and simple evaporative type, Bootstrap and Bootstrap evaporative type, regenerative type, reduced ambient. Limitation, merits and comparison.

Simple vapour compression cycle: pressure-enthalpy diagram, Ewing's construction, Suction state for maximum COP. Standard rating cycle and effect of operating conditions, (Evaporator pressure, condenser pressure, suction vapour super heat, liquid sub cooling, liquid vapour regenerative heat exchanger) Deviation of actual vapour compression cycle with that of theoretical.

UNIT-2

Multi Temperature: Method of improving the COP, optimum inter state pressure for two stages refrigeration system, Multi stage or compound compression with flash inter cooler, single expansion valve and multi expansion valve. Multi evaporator system with single compressor, individual compressor with compound compression, single expansion valve and multi-expansion valve.

Production of Low Temperature: Limitations of simple vapour compression system, multistage system, cascade system, production of solid carbon dioxide, Joule-Thomson effect, liquification of gases, hydrogen, helium, application of low temperature, Cryogenic insulation.

UNIT-3

Vapour Absorption System: Simple vapour absorption system, Maximum co-efficient of performance, modification of simple vapour absorption system, actual vapour absorption cycle and its representation on Enthalpy –composition diagram, absorption system calculation. Rich and poor solution concentration. Lithium Bromide water system. Steam Jet Refrigeration

UNIT-4

Application: Manufacture and treatment of metal, industrial medical, civil engineering, solar refrigeration, ice manufacturing and food preservation.
Design consideration of compressors, condensers, expansion devices, evaporators. Properties of refrigerants and mixture of refrigerant.

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Reference/Text Books:

1. Refrigeration and Air-conditioning by C.P. Arora.
2. Mechanical Refrigeration by Sporks and Diffio.
3. ASHARE Handbook (Fundamentals) by ASHARE.
4. Thermal Environment Engineering by Threlkeld.
5. Refrigeration and Air conditioning by Stocker, Mc-Graw Hill.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining **four** questions by selecting **only one question from each unit.***

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Semester)
(THERMAL ENGINEERING)

MTTH-907	DESIGN OF THERMAL SYSTEMS						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3

Purpose	**To make the students aware of the design and optimization of thermal systems using various conceptual theories. Also to understand the various costs and economic factors associated with thermal systems.**
	Course Outcomes
CO 1	**To study various types of models of thermal systems. Also to understand the concept of curve fitting and simulation.**
CO 2	**Understand initial design and various steps of acceptable design in thermal systems. To discuss the various application areas for the design of thermal systems.**
CO 3	**To study calculation of interest, worth of money as a function of time. Also to understand various payments, taxes associated along with economic factor in design consideration.**
CO 4	**Enable the students to understand the various optimization methods in the designing of thermal systems. Also to study the concept of geometric, linear and dynamic programming.**

UNIT-1

Modeling of Thermal System, types of Models, mathematical Modeling, Curve Fitting, linear algebraic Systems, Numerical Model for a System, System Simulation, Methods of Numerical Simulation.

UNIT-2

Acceptable Design of Thermal System, Initial Design, Design Strategies, Design of System for Different Application Area, Additional Consideration for a Practical System,

UNIT-3

Economic Consideration, calculation of Interest, Worth of money as a function of time, series of payments, raising capital,. Taxes, economic factor in design consideration

UNIT-4

Problem Formulation For Optimization, Optimization Methods, Optimization of Thermal Systems, Practical Aspect in Optimal design, Lagrange Multipliers, Optimization of Constrained and Unconstrained Problems, applicability to thermal systems, search method, single variable problem, multi-variable constrained optimization, examples of thermal systems, geometric, linear and dynamic programming, knowledge–based design and additional considerations.

Reference/Text Books:

1. Y Jaluria, Design and Optimization of Thermal Systems, CRC Press-2007
2. N.V. Suryanarayana, Design and Simulation, MGH 2002
3. W.F.Stoecker, Design of Thermal Systems, TMH

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Semester) (THERMAL ENGINEERING)

MTME-809	RESEARCH METHODOLOGY AND OPTIMIZATION TECHNIQUES						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	To impart knowledge about the various types of refrigeration systems.						
Course Outcomes							
CO 1	Understand the concept of formulation of a research problem and Taguchi methodology.						
CO 2	To get familiarize with the use of software and report writing.						
CO 3	Knowledge about the linear programming methods and applications.						
CO 4	Understand the concepts of different optimization techniques and their application.						

UNIT I

Introduction to research methodology, various types of techniques, alternative approaches to the study of the research problem and problem formulation. formulation of hypotheses, feasibility, preparation and presentation of research proposal.

Introduction to experimental design, Taguchi method, concept of orthogonal array, primary and secondary data collection, S/N ratio, validation, regression and correlation analysis. tests of significance based on normal. T and chi square distributions. analysis of variance.

UNIT II

Edition, tabulation & testing of hypotheses, interpolation of results, presentation, styles for figures, tables, text, quoting of reference and bibliography. Use of software for statistical analysis like SPSS, Minitab or Matlab, Report writing, preparation of thesis, use of software like MS Office.

The course will include extensive use of software, reporting writing and seminars in tutorial class.

UNIT III

Integer linear programming methods and applications, Introduction to integer non-linear programming, Basics of geometric programming.

Multi-objective optimization methods and applications, Formulation of problems – Separable programming and stochastic programming.

UNIT IV

Introduction to Genetic algorithms, neural network based optimization and optimization of fuzzy systems, Evolutionary Algorithm and Ant Colony Optimization techniques.

Note: - Some of the algorithm is used to be exercised using MAT LAB

Reference/Text Books:

1. C.R Kothari, Research Methodology, WishwaPrakashan
2. P.G Triphati, Research Methodology, Sultan Chand & Sons, N.Delhi
3. Fisher, Design of Experiments, Hafner
4. Sadhu Singh, Research Methodology in Social Sciences, Himalya Publishers
5. Kalyanmoy Deb, Optimization for Engineering design – algorithms and examples. PHI,New Delhi,1995.

6. SingiresuS.Rao, “Engineering optimization –Theory and practices”, John Wiley & Sons
7. Garfinkel, R.S. and Nemhauser, G.L., Integer programming, John Wiley & Sons, 1972.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining **four** questions by selecting **only one question from each unit.***

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Semester) (THERMAL ENGINEERING)

MTTH-911	ADVANCED HEAT TRANSFER LAB						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
-	-	2	1	60	40	100	-
Purpose	To design and conduct experiments, and acquire, analyze and interpret data.						
Course Outcomes							
CO 1	To study the heat pipe and demonstrate its super thermal conductivity.						
CO 2	To understand the unsteady state heat conduction.						
CO 3	To analyze the heat transfer characteristics in convective heat transfer.						
CO 4	To analyze the heat transfer characteristics for different heat exchangers.						

List of Experiments

1. Study of variation of emissivity of test plate with absolute temperature.
2. To demonstrate the super thermal conductivity of heat pipe.
3. To determine natural convective heat transfer coefficient and to calculate and to plot variation of natural convective heat transfer coefficient along the vertical tube.
4. To determine the LMTD, overall heat transfer coefficient and effectiveness of evaporative heat exchanger.
5. To find out heat transfer coefficient of drop wise and film wise condensation at various flow rates of water.
6. To study different types of heat enhancement techniques.
7. To determine the Biot number, Fourier number and heat transfer coefficient for unsteady heat transfer.
8. To calculate heat transfer coefficient of the fluidized bed.
9. To find out the overall heat transfer coefficient and LMTD of a finned tube heat exchanger.
10. To find out the overall heat transfer coefficient and LMTD of a plate type heat exchanger.
11. To find out the heat flux and temperature difference between metal & liquid in a two phase transfer unit.
12. To determine the overall heat transfer co-efficient under unsteady state conditions at different temperatures and heat transfer coefficient at boiling point.

Note: Total eight experiments are to be performed selecting at least six from the above list.

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Second Semester

M.

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Semester) (THERMAL ENGINEERING)

MTTH-902	COMPUTATIONAL FLUID DYNAMICS						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	**To familiarize the students with the basic concepts of Computational Fluid Dynamics.**						
Course Outcomes							
CO 1	**Develop and understand the basic equations which govern the fluid flow and heat transfer phenomena.**						
CO 2	**Classify the different types of differential equations and analyze their mathematical behaviour.**						
CO 3	**Understand the basic concepts of discretization and error analysis. Also develop the understanding of some simple CFD techniques.**						
CO 4	**Analyze the steady and unsteady heat conduction & combined conduction diffusion problems using control volume formulation.**						
CO 5	**Apply CFD to fluid flow problems.**						

UNIT-1

Introduction: Introduction to C.F.D., comparison of the three basic approaches in engineering problem solving- analytical, experimental and computational; models of the flow, substantial derivative, governing equations – continuity equation, momentum equation, energy equation, Navier-Stokes equation; physical boundary conditions.

Mathematical behavior of governing equations: classification of quasi linear partial differential equations, general method of determining the classification of partial differential equations, general behavior of hyperbolic, parabolic, elliptic equations.

UNIT-2

Discretization: Introduction, finite difference method, difference equations, explicit and implicit approaches, error and stability analysis.

Simple CFD Techniques: Lax-Wendroff technique, MacCormack's technique, space marching, relaxation technique, pressure correction technique, SIMPLE algorithm.

UNIT-3

Heat Conduction: control volume formulation of one-dimensional steady state diffusion, unsteady one-dimensional diffusion, two and three dimensional diffusion problems, over and under relaxation.

Heat Convection & Diffusion: Steady one-dimensional convection and diffusion, central differencing scheme, upwind differencing scheme, exact solution, exponential, hybrid, and power law schemes, discretization equations for two dimensions & three dimensions.

UNIT-4

Fluid Flow: CFD solution of subsonic-supersonic isentropic nozzle flow, purely subsonic isentropic flow, viscous incompressible flow, solution of incompressible Couette flow problem by F.D.M., solution of Navier-Stokes equations for incompressible flows using MAC and SIMPLE methods.

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Reference/Text Books:

1. Numerical Heat Transfer and Fluid Flow by Suhas V. Patankar, Ane Books.
2. Computational fluid dynamics by John D.Anderson, Jr, McGraw Hill.
3. An Introduction to Computational Fluid Dynamics, H. Versteeg & W. Malalasekra, Pearson.
4. An Introduction to CFD: Development, Application & Analysis, Atul Sharma, Ane Books.
5. Computational Fluid Flow & Heat Transfer, K. Muralidhar& T. Sundararajan.
6. Introduction to Computational fluid dynamics by Anil W. Date

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Semester)
(THERMAL ENGINEERING)

MTTH-904	ADVANCED INTERNAL COMBUSTION ENGINES						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3

Purpose	**Enable the students to understand the various theories, cycles and processes of Internal Combustion Engines. Also to understand the various devices and types of emission associated with engines.**
	Course Outcomes
CO 1	**To analyze the cycles, operating variables and the basic concepts of internal combustion engines. Also to learn various processes and comparison of real and fuel air cycles. To understand the thermo chemistry of fuel-air mixtures. Also to study the combustion charts of the fuel-air mixture in internal combustion engines.**
CO 2	**To understand the gas exchange processes and motion of charge in the cylinder and its effects on combustion process in SI and CI engines and control the pollutant formation.**
CO 3	**Understand the combustion in SI and CI engine with the thermodynamics of the combustion.**
CO 4	**Understand modern concepts like Lean burn, HCCI, GDI, MPFI and evaluate method for pollution control.**

UNIT-1

Cycle Analysis: Fuel-air cycles, variable specific heats, dissociation, effect of operating variables, comparison with air standard cycle. Actual cycles, time and heat loss factors, exhaust blow down, comparison of real engine cycle and fuel air cycle, availability analysis of engine processes.

Thermochemistry of fuel-air mixtures: composition of air and fuels, first law and second law applied to combustion, unburned mixture composition, combustion charts.

UNIT-2

Heat Transfer: Heat transfer and engine energy balance, parameters affecting heat transfer, convective and radiative heat transfer, measurement of instantaneous heat transfer rate, thermal loading.

Gas Exchange Processes: flow through valves and ports, exhaust gas flow rate, scavenging in two stroke engines, scavenging models, actual scavenging processes, supercharging and turbocharging, types and methods of supercharging, basic relationships, compressors, turbines, wave-compression devices, effects and limitations, charge cooling.

UNIT-3

Combustion: combustion in SI engines, thermodynamic analysis of SI engine combustion, burned and unburned mixture states, flame structure and speed, cycle variations, spark ignition, abnormal combustion, combustion in CI engines, types, CI engine combustion model, analysis of cylinder pressure data, fuel spray behavior, ignition delay, mixing controlled combustion.

UNIT-4

Fuel Injection: fuel injection systems, mechanism of spray formation, electronic injection systems, MPFI system, feedback systems, flow in intake manifolds, design requirements.

Pollution Formation and Control: trends in vehicle emission standards, unburned hydrocarbon emissions, nitrogen oxides, CO, particulate emissions, exhaust gas treatment, non-exhaust emissions.

Reference/Text Books:

1. Internal Combustion Engine Fundamentals by J.B. Heywood, McGraw Hill.
2. I.C. Engine Vol. 1 & II by C.P. Taylor, MIT press.
3. Internal Combustion Engines by V. Ganesan, Tata McGraw Hill.
4. Thermodynamics and Gas Dynamic of I.C. Engine, Vol. I & II by Horlock and Winterbone.
5. I.C. Engine, Vol. I & II by Benson and Whitehouse.
6. Thermodynamic Analysis of Combustion Engines, by Campbell.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining* ***four*** *questions by selecting* ***only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Semester) (THERMAL ENGINEERING)

MTTH-906	FINITE ELEMENT METHODS						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3

Purpose	To acquaint the students with fundamentals and various methods for solving the finite element problems. Also FDM, convergence and stability of FD scheme.
Course Outcomes	
CO 1	To understand the basic steps in FEM formulation. Also to study various concepts associated and assembly alongwith the boundary conditions in FEM formulation.
CO 2	To understand how FEM problem is formulated in 1-D elements. Also to discuss shape functions, h and p approximations; and various solvers associated in FEM.
CO 3	To study FEM formulation of 2-D element using various methods like Galerkin approach, Weighted Residual etc. Also to understand the natural co-ordinates, numerical integration and various other concepts related to 2-D FEM formulation.
CO 4	Understand the axi-symmetric problems along with plane stress and plane strain problems with regards to solid mechanics. Also to discuss various elements of FEM, FEM with CI continuity and FDM problems.

UNIT-1

Basic Steps in FEM Formulation, General Applicability of the Method; Variational Functional, Ritz Method.

Variational FEM : Derivation of Elemental Equations, Assembly, Imposition of Boundary Conditions, Solution of the Equations.

UNIT-2

1-D Elements, Basis Functions and Shape Functions, Convergence Criteria, h and p Approximations.

Natural Coordinates, Numerical Integration, Gauss Elimination based Solvers. Computer implementation: Pre-processor, Processor, Post-processor.

UNIT-3

Alternate Formulation: Weighted Residual Method, Galerkin Method; Problems with C1 Continuity: Beam Bending, Connectivity and Assembly of C1 Continuity Elements.

Variational Functional; 2-D Elements (Triangles and Quadrilaterals) and Shape Functions. Natural Coordinates, Numerical Integration, Elemental Equations, .Connectivity and Assembly, Imposition of Boundary Conditions.

UNIT-4

Axisymmetric (Heat Conduction) Problem, Plane Strain and Plane Stress Solid Mechanics Problems.

2017-2018

Sub-parametric, Iso-parametric and Super-parametric Elements; Elements with C1 Continuity. Free Vibration Problems, Formulation of Eigen Value Problem, FEM Formulation. Time-dependent Problems, Combination of Galerkin FEM and FDM (Finite Difference Method), Convergence and Stability of FD Scheme.

Reference/Text Books:

1. C. S. Krishnamoorty, Finite element analysis, Tata McGraw Hill
2. J. N Reddy, An introduction to Finite element method, Tata Mc. Graw Hill
3. Y. M. Desai, Finite Element Method with applications in engineering, Pearson Education India
4. Nonlinear Finite Elements for Continua and Structures (Paperback) by Belytschko (shelved 1 time as *finite-elements*)
5. The Finite Element Method for Three-Dimensional Thermomechanical Applications (Hardcover) by Guido Dhondt (shelved 1 time as *finite-elements*)
6. Numerical Solution of Partial Differential Equations by the Finite Element Method (Paperback) by Claes Johnson (shelved 1 time as *finite-elements*)

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining* ***four*** *questions by selecting* ***only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Semester) (THERMAL ENGINEERING)

MTTH-908	SOLAR ENERGY						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	To acquaint the students with fundamentals of solar heating systems and devices.						
Course Outcomes							
CO 1	Understanding of principles and technologies for solar thermal energy collection, conversion and utilization.						
CO 2	Understanding of solar heating systems, liquid based solar heating systems for buildings.						
CO 3	Identify and understand solar thermal system's components and their function.						
CO 4	Analyze hot water load and solar resource data and use this information to properly size a solar thermal system.						

UNIT-1

Solar Radiation: Characteristics, Earth-sun relation, Estimation on horizontal and tilted surfaces, Radiation characteristics of opaque and transparent material.

Flat Plate Collectors: Description, theory, Heat capacity effects, Time constant, Measurement of thermal performance, Air heaters.

UNIT-2

Evacuated Tubular Collectors: One axis, Two axis, Solar tracking, Cylindrical, Spherical and Parabolic and Paraboloid concentrators. Composite collectors, Central receiver collectors.

Heat Storage: Sensible and latent heat storage, Chemical energy system, performance calculations.

UNIT-3

Flow Systems: Natural and forced flow systems, Water heating systems for domestic, industrial and space heating requirements, Solar distillation.

Solar Heating and Cooling: Direct, indirect and isolated heating concepts, Cooling concepts, Load calculation methods, Performance evaluation methods.

UNIT-4

Solar Thermal Power Generation: Introduction, Paraboloidal concentrating systems, Cylindrical concentrating systems, Central receiver system.

Solar Refrigeration and Air Conditioning Systems: Introduction, Solar refrigeration and air conditioning systems, Solar desiccant cooling.

2017-2018

Reference/Text Books:

1. Solar Thermal Engineering Process by Duffie and Beckman.
2. Advanced Solar Energy Technology by H.P. Garg.
3. Solar Energy by S.P. Sukhatme.
4. Solar Energy by J.S. Hsieh.
5. Solar Thermal Engineering by P.J. Lunde.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining **four** questions by selecting **only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Semester) (THERMAL ENGINEERING)

MTTH-910	COMPUTATIONAL FLUID DYNAMICS LAB						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
-	-	2	1	60	40	100	-
Purpose	To acquaint the students with fundamentals of programming of 1 D and 2 D heat transfer and fluid flow problems using finite differencing.						
Course Outcomes							
CO 1	Develop an understanding of the difference between dimensional and non-dimensional programming techniques.						
CO 2	Understanding of fundamentals of programming of heat transfer in pin fin problems.						
CO 3	Understanding of fundamentals of programming of fluid flow problems.						
CO 4	Understanding of fundamentals of programming of steady and transient heat conduction problems.						

List of Experiments

1. To make and validate a computer programme for the one dimensional pin fin steady state heat conduction.
2. To make and validate a computer programme for the one dimensional transient heat conduction.
3. To make and validate a computer programme for the plate in two dimensions in steady state conduction.
4. To make and validate a computer programme for the plate in two dimensions in transient state.
5. To make and validate a computer programme for the comparison of explicit, implicit, semi- implicit method of computation of heat transfer equation.
6. To make and validate a computer programme for the fully developed laminar flow in circular pipe.
7. To make and validate a computer programme for the coutte flow.
8. To make and validate a computer programme to solve a model problem by stream function vorticity method.
9. To make a project by using MAC /SIMPLER method

Note: Total eight experiments are to be performed selecting at least six from the above list.

2017-2018

Elective-I

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2^{nd} Semester) (THERMAL ENGINEERING)

MTTH-914	ADVANCED THERMODYNAMICS						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	**To acquaint the students with fundamentals of advanced thermodynamics.**						
	Course Outcomes						
CO 1	**Understand the thermodynamic process and the methods for analyzing thermodynamic properties.**						
CO 2	**Determine the direction of the process by the analysis of exergy, entropy, free energy, etc., master the property equations and thermodynamic properties of real gases, master the methods for analyzing multi-component systems.**						
CO 3	**Acquire basic knowledge of chemical thermodynamics, and grasp the thermodynamic processes and properties of special systems.**						
CO 4	**Develop the skill to analyze the Maxwell - Boltzmann statistics, Bose Einstein statistics and Fermi Dirac statistics.**						

UNIT-I

Review of basic thermodynamic principles; entropy; availability; irreversibility; first and second law analysis of steady and unsteady systems;
General thermodynamics relations; Fundamentals of partial derivatives; relations for specific heats; internal energy enthalpy and entropy; Joule - Thompson coefficient; Clapeyron equation.

UNIT-II

Multi component systems; Review of equation of state for ideal and real gases; thermodynamic surfaces; gaseous mixtures; fugacity; ideal solutions; dilute solutions; activity; non ideal liquid solutions.

Multi component phase equilibrium; Criteria of equilibrium; stability; heterogeneous equilibrium; binary vapour liquid systems; the nucleus of condensation and the behaviour of stream with formation of large and small drops; Gibbs Phase rule; higher order phase transitions.

UNIT-III

Thermodynamics of chemical reaction (combustion); internal energy and enthalpy - first law analysis and second law analysis; basic relations involving partial pressures; third law of thermodynamics; chemical equilibrium and chemical potential equilibrium constants; thermodynamics of low temperature.

UNIT-IV

Statistical mechanics - Maxwell - Boltzmann statistics; microstate and macro-states; thermodynamic probability; entropy and probability Bose Einstein statistics; Fermi Dirac statistics.

Elementary concepts of irreversible thermodynamics.

2017-2018

Reference/Text Books:

1. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, F.W.Sears and G.L.Salinger, Narosa Publishing House, New Delhi
2. Engineering Thermodynamics, Zemansky, Mc Graw Hill.
3. Bejan, Advanced Engineering Thermodynamics, John Wiley and sons.
4. Engineering thermodynamics by G. Rogers and Y. Mayhow
5. Engineering Thermodynamics- a generalized approach by P.L Dhar, Elsevier publication.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining* ***four*** *questions by selecting* ***only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Semester) (THERMAL ENGINEERING)

MTTH-916	RENEWABLE ENERGY & ENERGY MANAGEMENT						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major test**	**Minor test**	**Total**	**Time (Hrs.)**
4	**-**	**-**	**4**	**60**	**40**	**100**	**3**
Purpose	**Students can understand the various renewable energy resources and their management along with advantages, disadvantages and applications. Also students can will be able to analyze the alternate fuels for diesel engines and power plants for developing power.**						
Course Outcomes							
CO 1	**To study the solar energy and energy from oceans. Also to understand the applications and various methods for power production.**						
CO 2	**Learn how to utilize wind for developing power and design various devices from wind. Also to understand hydro power station and its classification.**						
CO 3	**Enable the students to utilize alternate fuels of IC engines and understand how to generate energy from wastes. Also to analyze various devices designed from biogas.**						
CO 4	**To learn Geothermal energy and energy conservation management. Also to study geothermal power plants along with their environmental and operational problems.**						

UNIT-1

Solar Energy: The sun as a perennial source of energy, direct solar energy utilization; solar thermal applications – water heating systems, space heating and cooling of buildings, solar cooking, solar ponds, solar green houses, solar thermal electric systems; solar photovoltaic power generation; solar production of hydrogen.

Energy from Oceans: Wave energy generation – energy from waves; wave energy conversion devices; advantages and disadvantages of wave energy; Tidal energy – basic principles; tidal power generation systems; estimation of energy and power; advantages and limitations of tidal power generation; ocean thermal energy conversion (OTEC); methods of ocean thermal electric power generation.

UNIT-2

Wind energy: Basic principles of wind energy conversion; design of windmills; wind data and energy estimation; site selection considerations.

Hydro power: Classification of small hydro power (SHP) stations; description of basic civil works design considerations; turbines and generators for SHP; advantages and limitations.

UNIT-3

Biomass and bio-fuels: Energy plantation; biogas generation; types of biogas plants; applications of biogas; energy from wastes.

UNIT-4

Geothermal energy: Origin and nature of geothermal energy; classification of geothermal resources; schematic of geothermal power plants; operational and environments problems.

2017-2018

Energy conservation management: The relevance of energy management profession; general principles of energy management and energy management planning; application of Pareto's model for energy management; obtaining management support; establishing energy data base; conducting energy audit; identifying, evaluating and implementing feasible energy conservation opportunities; energy audit report; monitoring, evaluating and following up energy saving measures/projects

Reference/Text Books:

1. Renewable energy resources. John W Twidell and Anthony D Weir.
2. Renewable energy – power for sustainable future, Edited by Godfrey Boyle. Oxford University Press in association with the Open University, 1996.
3. Renewable energy sources and their environmental impact, .S.A.Abbasi and Naseema Abbasi Prentice-Hall of India, 2001.
4. Non-conventional sources of energy, G.D. Rai. Khanna Publishers, 2000.
5. Solar energy utilization, G.D. Rai. Khanna Publishers, 2000.
6. Renewable and novel energy sources, S. L. Sah. M. I. Publications, 1995.
7. Energy Technology, S.Rao and B.B. Parulekar.Khanna Publishers, 1999.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining* ***four*** *questions by selecting* ***only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Semester) (THERMAL ENGINEERING)

MTTH-918	CONVECTIVE HEAT TRANSFER						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	To impart an in depth knowledge about the basic concepts of the convective heat transfer.						
Course Outcomes							
CO 1	Review basic concepts and differentiate between laminar forced convection external and internal flows.						
CO 2	Develop an understanding of boundary layer flow in external and internal natural convection.						
CO 3	Analyze the turbulent boundary layer and duct flows.						
CO 4	Understand the mechanism of phase change and convection in porous media.						

UNIT-1

Fundamental Principles: Continuity, momentum and energy equations, Second law of thermodynamics, Rules of Scale analysis, Concept of Heat line visualization.

Laminar Forced Convection-External Flows: Boundary layer concept, velocity and thermal boundary layers, governing equations, similarity solutions, various wall heating conditions, Flow past a wedge and stagnation flow, blowing and suction, entropy generation minimization, heatlines in laminar boundary layer flow.

Laminar Forced Convection-Internal Flows: Fully developed laminar flow, heat transfer to fully developed duct flow, constant heat flux and constant wall temperature, heat transfer to developing flow, heatlines in fully developed duct flow.

UNIT-2

External Natural Convection: Boundary layer equations, Scale analysis, Low and high Prandtl number fluids, integral solution, similarity solution, uniform heat wall flux, conjugate boundary layers, vertical channel flow, combined natural and forced convection, vertical walls, horizontal walls, inclined walls, horizontal and vertical cylinder, sphere.

Internal Natural Convection: transient heating from side, boundary layer regime, isothermal and constant heat flux side walls, partially divided and triangular enclosures, enclosures heated from below, inclined enclosures, annular space between horizontal cylinders and concentric spheres.

UNIT-3

Transition to Turbulence: empirical transition data, scaling laws of transition, buckling of inviscid streams, instability of inviscid flow.

Turbulent Boundary Layer Flow: Boundary layer equations, mixing length model, velocity distribution, heat transfer in boundary layer flow, flow over single cylinder, cross flow over array of cylinders, Natural convection along vertical walls.

Turbulent duct flow: velocity distribution, friction factor and pressure drop, heat transfer coefficient, isothermal wall, uniform wall heating, heatlines in turbulent flow near a wall, optimal channel spacing.

UNIT-4

Convection with Change of Phase: Condensation, laminar and turbulent film on a vertical surface, film condensation, drop condensation, Boiling, pool boiling regimes, nucleate boiling, film boiling and flow boiling, contact melting and lubrication, melting by natural convection.

Convection in Porous Media: Mass conservation, Darcy and Forchheimer flow models, enclosed porous media heated from side, penetrative convection, enclosed porous media heated from below.

Reference/Text Books:

1. Convection Heat Transfer by A. Bejan, Wiley Publications.
2. Convective Heat Transfer by Louis C. Burmeister, Wiley Publications.
3. Convective Heat and Mass Transfer by W.M. Kays and M.E. Crawford, McGraw Hill.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining* ***four*** *questions by selecting* ***only one question from each unit.***

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Semester) (THERMAL ENGINEERING)

MTME-920	MEASUREMENTS IN THERMAL ENGINEERING						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	Students have a basic understanding of instruments for measurement of various variables with regards to the thermal systems. Also to understand the concepts of different devices and their variable measurement methods.						
Course Outcomes							
CO 1	Enable the students to draw signal flow graph of measurement systems. Also to analyze the experimental data and various sensing devices.						
CO 2	To study the various instruments for the measurement of flow and pressure. Also to understand the basic concept of thermometry along with its temperature measurement by mechanical, electrical and radiation effects.						
CO 3	To understand the measurement of nuclear, thermal radiation, torque and strain measurements. Also to study the thermal and transport property measurement.						
CO 4	To learn how to design the experiments using examples and with the help of DAS. Also to study various air pollution standards and how to measure these pollutants through various instruments.						

UNIT-1

Basics of Measurements: Introduction, General measurement system, Signal flow diagram of measurement system, Inputs and their methods of correction.

Analysis of Experimental Data: Causes and types of errors in measurement, Propagation of errors, Uncertainty analysis, Regression analysis, Statistical analysis of Experimental data.

Sensing Devices: Transducers-LVDT, Capacitive, piezoelectric, photoelectric, photovoltaic, Ionization, Photoconductive, Hall-effect transducers, etc.

UNIT-2

Pressure Measurement: Different pressure measurement instruments and their comparison, Transient response of pressure transducers, dead-weight tester, low-pressure measurement.

Thermometry: Overview of thermometry, temperature measurement by mechanical, electrical and radiation effects. Pyrometer, Thermocouple compensation, effect of heat transfer.

Flow Measurement: Flow obstruction methods, Magnetic flow meters, Interferometer, LDA, flow measurement by drag effects, pressure probes, other methods.

UNIT-3

Thermal and Transport Property Measurement: Measurement of thermal conductivity, diffusivity, viscosity, humidity, gas composition, pH, heat flux, calorimetry, etc.

2017-2018

Nuclear, Thermal Radiation Measurement: Measurement of reflectivity, transmissivity, emissivity, nuclear radiation, neutron detection, etc.

Other measurements: Basics in measurement of torque, strain.

UNIT-4

Air-Pollution: Air-Pollution standards, general air-sampling techniques, opacity measurement, sulphur dioxide measurement, particulate sampling technique, combustion products measurement.

Advanced topics: Issues in measuring thermo physical properties of micro and Nano fluids.

Design of Experiments: Basic ideas of designing experiments, Experimental design protocols with some examples and DAS

Reference/Text Books:

1. Mechanical Measurements by Thomas G. Beckwith, Pearson Publications.
2. Measurement Systems by Ernest O. Doebelin, Tata McGraw Hill Publications.
3. Experimental Methods for Engineers by J.P. Holman, Tata McGraw Hill Publications.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining* ***four*** *questions by selecting* ***only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Semester) (THERMAL ENGINEERING)

MTTH-922	DESIGN OF HEAT TRANSFER EQUIPMENTS						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	To acquaint the students with the different types of heat transfer equipments and their design approaches.						
Course Outcomes							
CO 1	Classify different heat exchangers and understand the different design approaches.						
CO 2	To impart knowledge about the various solution methods for determining exchanger effectiveness.						
CO 3	Analyze the various heat exchanger performance characteristics.						
CO 4	Understand the basic fundamentals for designing of hair pin heat exchangers and cooling towers.						
CO 5	To study the design of furnaces and other thermal devices.						

UNIT-1

Classification of Heat Exchangers: Introduction, Classification, Overview of Heat Exchanger Design Methodology, Process and Design Specifications, Thermal and Hydraulic Design, Mechanical Design, Optimum Design , Heat Exchanger Variables and Thermal Circuit, Assumptions, Basic Definitions, ε - NTU Method , The P-NTU Method , TEMA , Multi-pass Exchangers, LMTD, Heat Exchanger Arrays and Multi-passing, Sizing and Rating Problems, Kern Method, Bell Delaware Method, Numerical on Shell and tube HEX.

Solution Methods for Determining Exchanger Effectiveness: Exact Analytical Methods, Approximate Methods, Numerical Methods, Matrix Formalism, Chain Rule Methodology , Flow-Reversal Symmetry, Design Problems, Longitudinal Wall Heat Conduction Effects, Multipass Exchangers, Non-uniform Overall Heat Transfer Coefficients, Temperature - Length - Combined Effect

UNIT-2

Heat Exchanger Pressure Drop Analysis: Importance of Pressure Drop, Devices, Extended Surface Heat Exchanger Pressure Drop, Tubular Heat Exchanger Pressure Drop, Tube Banks, Shell-and-Tube Exchangers, Plate Heat Exchanger Pressure Drop, Pipe Losses, Non-dimensional Presentation of Pressure Drop Data

Heat Transfer Characteristics: Dimensionless Surface Characteristics, Experimental Techniques for Determining Surface Characteristics, Steady-State Kays and London Technique, Wilson Plot Technique, Transient Test Techniques, Friction Factor Determination, Hydrodynamic ally Developing Flows, Thermally Developing Flows, Extended Reynolds Analogy, Heat Exchanger Surface Geometrical Characteristics, Selection of Heat Exchangers and Their Components, Temperature Difference Distributions

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Unit-3

Hair-Pin Heat Exchangers: Introduction to Counter-flow Double-pipe or Hair-Pin heat exchangers, Industrial versions of the same, Film coefficients in tubes and annuli, Pressure drop, Augmentation of performance of hair-pin heat exchangers, Series and Series-Parallel arrangements of hair-pin heat exchangers, Comprehensive Design Algorithm for hair-pin heat exchangers, Numerical Problems.

Cooling tower fundamentals: Types, Nomenclature, material for construction, Structural components in details, Mechanical components (Fan, Speed reducer, Valves, Safety), Electrical components, Thermal performance testing – conduction and evaluation.

Unit-4

Furnace: Furnace, Types, Parts used in furnace, Nozzles used, Heat transfer related design of systems, Insulations, Applications in process industries.

Thermal Devices: Heat pipe, Thermal interface material, use of nano particle in heat transfer equipments, Steam Trap, Electronics cooling systems, Thermal interface materials, Heat transfer augmentation techniques

Reference/Text Books:

1. Cooling Tower Fundamentals by John C. Hensley, SPX Cooling Technologies.
2. Heat Exchanger Selection, Rating and Thermal Design by Sadik Kakac, Hongtan Liu, Anchasa Pramunjanaroenkij, CRC Press.
3. Compact Heat Exchangers by W.M. Kays and A.L. London, McGraw Hill Publications.
4. Process Heat Transfer by D. Q. Kern, McGraw Hill Publications.
5. Process Heat Transfer – Principles and Applications by R.W. Serth, Academic Press.
6. Heat Pipes Theory, design and Applications by D.S. Steinberg, Wiley Publications.
7. Fundamentals of Heat Exchanger Design by Ramesh K. Shah, Dusan P. Skulic, Wiley Publications.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining **four** questions by selecting **only one question from each unit.***

2017-2018

Third Semester

2017-2018

Elective-II

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Semester) (THERMAL ENGINEERING)

MTTH-915	AIR CONDITIONING						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3

Purpose	To acquaint the students with the fundamental concepts of air conditioning.
Course Outcomes	
CO 1	Student will be able to create the psychrometric properties of the air and water mixtures in tabular and chart form.
CO 2	Will be able to calculate the air-conditioning load of a given space.
CO 3	Will be able to select or design a suitable air conditioning system.
CO 4	Confidence in applying the subject to any practical problems with different controls.
CO 5	Suggesting suitable ventilation and design the duct and air distribution system.

UNIT-1

Introduction and Human Comfort

Psychometric and psychometric properties, psychometric relations and processes, adiabatic temperature, psychometric chart, summer and winter air-conditioning system, year-round air-conditioning, factors influencing-human comfort, effective temperature, factors governing optimum effective temperature.

UNIT-2

Cooling Load Calculations

Types of loads, building heat transmission, solar-radiation infiltration, occupants, electric lights, products load, other internal heat sources, fresh-air miscellaneous steams, design of air-conditioning systems.

Air Conditioning Systems

Central station, unitary, distinct, self-contained direct expansion, all water, all air, air-water system, arrangement of components, air-cleaning and air filters, humidifiers, dehumidifiers air-washers, fan and blowers, grills and registers.

UNIT-3

Air Conditioning Control System

Heating and cooling coils, basic principles of control system, temperature humidity, pre-heating and humidification, cooling and dehumidification, reheat and all-year conditioning control systems. Elements of control, Deflective element (bimetallic, bulbs and below, electrical resistance, electromagnetic sensitive and pressure sensitive, controlling room conditions at partial load (ON-OFF control), by pass control, reheat control and volume control).

UNIT-4

Miscellaneous

Evaporative cooling, heating system, ventilation and ventilation standards, thermal insulation duct design and air-distribution system, noise and noise control, solar air-conditioning. Transport air conditioning, air conditioning of special type of buildings, air conditioning of textile industry, photographic industry, theatre auditorium, hospitals etc.

2017-2018

Reference/Text Books:

1. Refrigeration and air conditioning by C.P. Arora.
2. Refrigeration and air conditioning by Jordan and Priester
3. Refrigeration and air conditioning by William
4. ASHARAE Hand Book (Fundamentals) ASHARAE
5. Elementary Refrigeration and air conditioning Stoecjer McGraw Hill
6. Air Conditioning Engineering Jones Arnold.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining* ***four*** *questions by selecting* ***only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Semester) (THERMAL ENGINEERING)

MTTH-917	CRYOGENIC ENGINEERING						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	**To understand the fundamentals of cryogenic engineering and its application.**						
Course Outcomes							
CO 1	**Student will be able to develop the thermodynamic properties of the any refrigerant and will be able to design the various components of the system.**						
CO 2	**Able to retrofit alternative methods Gas separation and purification in the existing system.**						
CO 3	**Selection of cryogenic system for different applications.**						
CO 4	**Carry out thermodynamic analysis of different liquefaction plants and suitable method of liquefaction.**						

UNIT-1

Gas liquefaction systems, thermodynamically ideal systems, Joule Thomson effect, adiabatic expansion; liquefaction system for air, Neon, hydrogen and helium, effect of component efficiencies on system performance.

UNIT-2

Gas separation and purification – principles, plant calculation, air, hydrogen, and helium separation systems.

UNIT-3

Cryogenic refrigeration systems, ideal and practical systems, cryogenic temperature measurement; cryogenic fluid storage and transfer systems, storage vessels and insulation, two-phase flow in cryogenics transfer systems, cool down process.

UNIT-4

Introduction to vacuum technology, low temperature properties of materials, pump down time, application of cryogenic systems, super-conductive devices, rocket and space simulation, cryogenics in biology and medicine, cryo-pumping.

Reference/Text Books:

1. Barron, R., Cryogenic Systems, McGraw-Hill, 1966.
2. Timmerhaus, K. D. and Flynn, T. M., Cryogenic Process Engineering, Plenum Press, 1989.
3. Scott, R. B., Cryogenic Engineering, D'Van-Nostrand, 1962.
4. Vance, R. W. and Duke, W. M., Applied Cryogenic Engineering, John Wiley, 1962.
5. Sitting, M. Cryogenic, D' Van-Nostrand, 1963.

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Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining* ***four*** *questions by selecting* ***only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Semester) (THERMAL ENGINEERING)

MTTH-919	COMBUSTION ENGINEERING						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	To impart the knowledge about the fundamentals of the mechanism of combustion engineering.						
	Course Outcomes						
CO 1	Understand the basic concepts of thermodynamics and combustion.						
CO 2	Develop the knowledge of the kinetics of the combustion and burning of condensed phase.						
CO 3	Able to explain the mechanism of flame propagation and its theories and the stability analysis.						
CO 4	Analyze the different pollutants generated due to combustion and their control technologies.						

UNIT-1

Introduction: Importance of combustion; Combustion equipments, Hostile fire problems, pollution problems arising from combustion.

Thermodynamics of Combustion: Enthalpy of formation; Enthalpy of reaction; Heating values; First & second laws; Analysis of reaction system, Chemical equilibrium, Equilibrium composition; Adiabatic & equilibrium, Flame temperature.

UNIT-2

Kinetics of Combustion: Law of mass action; Reacting rate; Simple and complex reaction; Reaction order & molecularity, Arhenius laws; Activation Energy; Chain reaction; Steady rate & Partial equilibrium approximation; chain explosion; Explosion limit and oxidation characteristics of hydrogen, Carbon monoxide, Hydrocarbons.

Burning of Condensed Phase: General mass burning considerations, Combustion of fuels, droplet in a quiescent and convective environment, Introduction to combustion of fuel sprays.

UNIT-3

Flames: Remixed flame structure & propagation of flames in homogeneous mixtures; Simplified Rankine Hugoniot relation, Properties of Hugoniot curve, analysis of Deflagration &detonation branches, Properties of Chapmen Jouguet wave, Laminar flame structure; Theories of flame propagation & calculation of flame speed measurements. Stability limits of laminar flames; Flammability limits & quenching distant, Burner design, Mechanism of flame stablization in laminar & turbulent flows, Flame quenching, Diffusion flames; Comparison of diffusion with premixed flame, combustion of gaseous fuel, jets burke & Schumann development.

UNIT-4

Ignition: Concept of ignition, Chain ignition, Thermal spontaneous ignition, Forced ignition.

Combustion Generated Pollution & its Control: Introduction, Nitrogen oxide, Thermal fixation of atmospheric nitrogen prompts, NO, Thermal NOx & control in combustors. Fuel NOx & control, post combustion destruction of NOx, Nitrogen dioxide, carbon monoxide Oxidation-Quenching, Hydrocarbons, Sulphur oxide.

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Reference/Text Books:

1. Internal Combustion Engines: Applied Thermo Sciences by Ferguson Colin R, John Wiley.
2. Engineering Fundamentals of the Internal Combustion Engine, Pulkrabek, Pearson Education India.
3. Instrumentation for Combustion and Flow in Engines, Durao D. F.G., Kluwer Aca.
4. Energy from Biomass: A review of Combustion and Gasification Technologies, Quaak Peter.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining **four** questions by selecting **only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Semester) (THERMAL ENGINEERING)

MTTH-921	NUCLEAR ENGINEERING						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	To familiarize the students with the basic concepts of nuclear engineering.						
Course Outcomes							
CO 1	Understand the concepts of Nuclear Physics fission chain reaction, thermalization of neutrons.						
CO 2	Determine the mass energy equivalence, energy release in fission & fusion, thermonuclear reaction, and reactor materials.						
CO 3	Acquire the knowledge of basic principles of reactor technology, neutron balance, reactor kinetics, Xenon poisoning, heat balance, production & transfer of heat to the coolant and types of nuclear reactors.						
CO 4	Develop the skill to analyze safety considerations & waste disposal and preparation of radio-isotopes & their use in medicine, agriculture & industry						

UNIT-1

Concepts of Nuclear Physics

The atom, structure, the nucleus, nuclear structure, atomic transmutation of elements, detection of radio-activity, particle accelerator, decay, natural of elements, nucleus interactions, decay rates, half-life, transuranic elements.

Neutorn Interaction

Advantages of using neutron, neutron moderation, fission chain reaction, thermalisation of neutrons, fast neutrons, prompt and delayed neutrons, fission products.

UNIT-2

Energy Release

Mass energy equivalence, mass defect, binding energy, energy release in fission & fusion, thermonuclear reaction, fusion bomb.

Reactor Materials

Fissile & fertile materials, cladding & shielding materials, moderators, coolants.

UNIT-3

Reactor Technology

Basic principles, fuel assembly, neutron balance, reactor kinetics, reactor coefficients, reactor stability, excess reactivity, Xenon poisoning, burnable absorbers, reactivity control, heat balance, production& transfer of heat to the coolant, structural considerations.

Nuclear Reactors

Types of nuclear reactors, pressurized water reactors, boiling water reactors, CANDU type reactors, gas cooled & liquid metal cooled reactors, fast breeder reactors.

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UNIT-4

Safety Considerations & Waste Disposal

Hazards, plant site selection, safety measures incorporated in; plant design, accident control, disposal of nuclear waste.

Health Physics & Radio-isotopes

Radiation: units, hazards, prevention, preparation of radio-isotopes & their use in medicine, agriculture & industry.

Reference/Text Books:

1. Nuclear Power Engineering by M.M. El-Wakel
2. Nuclear Power Plant by Taylor
3. Introduction to Nuclear Engineering by Stephenson.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining **four** questions by selecting **only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Semester) (THERMAL ENGINEERING)

MTTH-923	JET AND ROCKET PROPULSION						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3

Purpose	To understand the fundamentals of jet and rocket propulsion.
Course Outcomes	
CO 1	The student will be able to explain the working of jet engines and rocket propulsion systems and also understanding of motion in space.
CO 2	The student will be able to describe liquid propellant rocket engines.
CO 3	The student will be able to discuss solid propellant rocket engines and explain rocket motor design approach.
CO 4	The student will be able to classify solid propellants and discuss the characteristics.
CO 5	The student will be able to explain the working of hybrid propellant rockets and select the process for rocket propulsion systems.

UNIT-1

Motion in Space: Requirement for Orbit: Motion of Bodies in space, Parameters describing motion of bodies, Newton's Laws of motion, Universal law of gravitational force, Gravitational field, Requirements of motion in space, Geosynchronous and geostationary orbits, Eccentricity and inclination of orbits, Energy and velocity requirements to reach a particular orbit, Escape velocity, Freely falling bodies, Means of providing the required velocities.

UNIT-2

Theory of Rocket Propulsion: Illustration by example of motion of sled initially at rest, Motion of giant squid in deep seas, Rocket principle and rocket equation, Mass ratio of rocket, Desirable parameters of rocket, Rocket having small propellant mass fraction, Propulsive efficiency of rocket, Performance parameters of rocket, Staging and clustering of rockets, Classification of rockets.

Rocket nozzle and Performance: Expansion of gas from a high pressure chamber, Shape of the nozzle, Nozzle area ratio, Performance loss in conical nozzle, Flow separation in nozzles, Contour or bell nozzles, Unconventional nozzles, Mass flow rates and characteristics velocity, Thrust developed by a rocket; Thrust coefficient, Efficiencies, Specific impulse and correlation with C* and CF, General Trends.

UNIT-3

Chemical Propellants: Small value of molecular mass and specific heat ratio, energy release during combustion of products, Criterion for choices of propellants, Solid propellants, Liquid propellants, Hybrid propellants.

Solid Propellants Rockets: Mechanism of burning and burn rate, Choice of index n for stable operation of solid propellant rockets, Propellant grain configuration, Ignition of solid propellant rockets, Pressure decay in chamber after propellant burnout, Action time and burn time, Factors influencing burn rate, Components of a solid propellant rocket.

UNIT-4

Liquid Propellant Rockets: Propellant feed system, Thrust chamber, Performance and choice of feed system cycle, Turbo pumps, Gas requirements for draining of propellants from storage tanks, Draining under microgravity condition, Trends in development of liquid propellant rockets.

Hybrid Rockets: Working principle, Choice of fuels and oxidizer, Future of hybrid rockets

Reference/Text Books:

1. Rocket Propulsion by M. Barrere, Elsevier Publications.
2. Rocket Propulsion Elements by G.P. Sutton, John Wiley Publications.
3. Rocket Propulsion by K. Ramamurthi, Macmillan Publishers.
4. Introduction to Rocket Technology by V.I. Feedesiev and G.B. Siniarev, Academic Press.
5. Gas Turbine Theory by H.I.H. Sarvanamuttoo, G.F.C. Rogers and H. Cohen, Pearson Prentice Hall.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining **four** questions by selecting **only one question from each unit.***

Elective-III

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Semester)
(THERMAL ENGINEERING)

MTTH-925	THERMAL MODELING AND ANALYSIS						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	This course provides the various mathematical modelling and analysis for designing the thermal systems. Also students can able to understand the dynamic behaviour of thermal systems.						
Course Outcomes							
CO 1	Enable the students to understand the basic concepts for designing the thermal systems. Also to discuss mathematical modelling of thermal systems using computer programmes.						
CO 2	To equip the students for modelling the thermal systems like heat exchangers, evaporators, condensers etc. Also to understand their solution procedures.						
CO 3	To understand the concepts of optimization and its various methods for solving the thermal problems. Also to study geometric, linear and dynamic programming.						
CO 4	To learn the dynamic behaviour of thermal systems. Also to learn stability analysis and non-linearity.						
CO 5	Enable the students to understand the basic concepts for designing the thermal systems. Also to discuss mathematical modelling of thermal systems using computer programmes.						

UNIT-I

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

Mathematical Modeling: Equation fitting, Empirical equation, Regression analysis, Different modes of mathematical models, Selection, Computer programmes for models.

UNIT-2

Modeling Thermal Equipments: Modeling heat exchangers, Evaporators, Condensers, Absorption and rectification columns, Compressor, Pumps, Simulation studies, Information flow diagram, Solution procedures.

UNIT-3

Systems Optimization: Objective function formulation, Constraint equations, Mathematical formulation, Calculus method, Dynamic programming, Geometric programming, Linear programming methods, Solution procedures.

UNIT-4

Dynamic Behavior of Thermal System: Steady state simulation, Laplace transformation, Feedback control loops, Stability analysis, Non-linearties.

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Reference/Text Books:

1. Hodge, B.K. and Taylor, R. P., Analysis and Design of Energy Systems, Prentice Hall (1999).
2. Bejan, A., Tsatsaronis, G. and Michel, M., Thermal Design and Optimization, John Wiley and Sons (1996).
3. Jaluria, Y., Design and Optimization of Thermal Systems, McGraw-Hill (1998).
4. Jaluria, Y., Design and Optimization of Thermal Systems, CRC Press (2008).
5. Ishigai, S., Steam Power Engineering Thermal and Hydraulic Design Principle, Cambridge University Press (1999).

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining* ***four*** *questions by selecting* ***only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Semester) (THERMAL ENGINEERING)

MTTH-927	NUMERICAL & OPTIMIZATION METHODS						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3

Purpose	Students will be able to understand how the various problems can be solved by different optimization methods. Also solutions of differential equations can be find out by various methods.
Course Outcomes	
CO 1	Enable the students to find out the errors in numerical calculations through general formula. Also to understand the concepts of interpolation and curve fitting.
CO 2	Able to understand the various differentiating and integrating methods along with their solutions. Also to find out the solutions of linear and non-linear system equations.
CO 3	To understand the concepts of eigen value and eigen vectors along with the solution of various differential and partial differential equations.
CO 4	Enable the students to understand various optimization methods and learn multi-variable optimization algorithm.
CO 5	Enable the students to find out the errors in numerical calculations through general formula. Also to understand the concepts of interpolation and curve fitting.

UNIT – I

Errors in Numerical Calculations: Introduction, Numbers and their accuracy, Absolute, relative and percentage errors and their analysis, General error formula.

Interpolation and Curve Fitting: Taylor series and calculation of functions, Introduction to interpolation, Lagrange approximation, Newton Polynomials, Chebyshev Polynomials, Least squares line, curve fitting, Interpolation by spline functions.

UNIT – II

Numerical Differentiation and Integration: Approximating the derivative, Numerical differentiation formulas, Introduction to Numerical quadrature, Newton-Cotes formula, Gaussion-Quadrature.

Solution of Linear Systems and Nonlinear Equations: Direct Methods, Gaussian elimination and pivoting, Matrix inversion, UV factorization, iterative methods for linear systems, Bracketing methods for locating a root, Initial approximations and convergence criteria, Newton-Raphson and Secant methods

UNIT – III

Solution of Differential Equations: Introduction to differential equations, Initial value problems, Euler's methods, Runge-Kutta methods, Taylor series method, Predictor- Corrector methods, Finite-difference method.

Partial Differential Equations, Eigen Values and Eigen Vectors: Solution of hyperbolic, parabolic and elliptic equations, eigen value problem, Power and inverse power methods, Jacobi's method for eigen value problems.

UNIT – IV

Optimization Methods: Optimal problem formulation, Engineering optimization problems; optimization algorithms: Single-variable optimization algorithms, optimality criteria, Bracketing methods, Region-elimination methods, Point estimation method.

Multi- Variable Optimization Algorithms: optimality criteria, Uni-directional search, Direct search methods: Evolutionary methods, Simplex search method, Gradient based methods: Cauchy's method, Newtons method, Application to Mechanical Engg. Problems, Non-traditional optimization algorithms, Genetic algorithms (GA), GA for constrained optimization, other GA operators, Multi objective Optimization, Concept of Pareto Optimality, Global optimization.

Reference/Text Books:

1. Numerical Methods for Mathematics, Science and Engineering by John H.Mathews, PHI New Delhi.
2. Applied Numerical Methods – Carnahan, B.H., Luthar, H.A. and Wilkes, J.O., Wiley, New York
3. Numerical Solution of Differential Equations, by M.K. Jain, Published by Wiley Eastern, New York.
4. Introductory Methods of Numerical Analysis by S.D. Sastry, Published by Prentice Hall of India.
5. Numerical Methods – Hornbeck, R.W., Pub.- Prentice Hall, Englewood Cliffs, N.J.
6. Optimization for Engineering Design : Algorithms and Examples by Kalyanmoy Deb, PHI new Delhi
7. Numerical Optimization Techniques for Engineering Design: With Applications by Garret N. Vanderplaats,Mcgraw Hill Series in Mechanical Engineering
8. Genetic Algorithms and Engineering Optimization by Mitsuo Gen, Runwei Cheng, John Wiley & Sons
9. Global Optimization in Engineering Design, by Ignacio E. Grossmann, Kluwer Academic Publisher
10. Optimization Concepts and Applications in Engineering, by Ashok D. Belegundu , Tirupathi R. Chandrupatla, Cambridge University Press, USA

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining **four** questions by selecting **only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Semester)
(THERMAL ENGINEERING)

MTTH-929	ADVANCED COMPUTATIONAL FLUID DYNAMICS						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	To familiarize the students with the basic concepts of Computational Fluid Dynamics.						
Course Outcomes							
CO 1	Revision of the basics of finite differences and finite volume methods.						
CO 2	Develop the understanding of the modeling of turbulence and its effects.						
CO 3	Analyze the convection diffusion problems and develop algorithms for pressure velocity coupling in steady flows and unsteady flows.						
CO 4	Develop skills to implement and handle boundary conditions; errors and uncertainty; and complex geometries.						
CO 5	Able to model the combustion phenomenon and radiative heat transfer using CFD.						

UNIT-1

Introduction: Revision of pre-requisite courses, finite differences and finite volume methods.

Turbulence and its modeling: transition from laminar to turbulent flow, descriptors of turbulent flow, characteristics of turbulent flow, effect of turbulent fluctuations on mean flow, turbulent flow calculations, turbulence modeling, Large eddy simulation, Direct Numerical Simulation.

UNIT-2

Finite volume method for convection-diffusion problems: Steady 1-D convection-diffusion, Conservativeness, Boundedness and Transportiveness, Central, Upwind, Hybrid and Power law schemes, QUICK and TVD schemes.

Pressure - velocity coupling in steady flows: Staggered grid, SIMPLE algorithm, Assembly of a complete method, SIMPLER, SIMPLEC and PISO algorithms, Worked examples of the above algorithms.

Finite volume method for unsteady flows: 1-D unsteady heat conduction, Explicit, Crank-Nicolson and fully implicit schemes, Transient problems with QUICK, SIMPLE schemes.

UNIT-3

Implementation of boundary conditions: Inlet, Outlet, and Wall boundary conditions, Pressure boundary condition, Cyclic or Symmetric boundary condition.

Errors and uncertainty in CFD modeling: Errors and uncertainty in CFD, Numerical errors, Input uncertainty, Physical model uncertainty, Verification and validation, Guide lines for best practices in CFD, Reporting and documentation of CFD results.

Methods for Dealing with complex geometries: Introduction, body-fitted co-ordinate grids, curvilinear grids, block structured and unstructured grids, discretization in unstructured grids, diffusion and convective term, treatment of source term, assembly of discretized equations, pressure-velocity coupling, extension of face velocity interpolation method to unstructured meshes.

UNIT-4

CFD modeling of combustion: Enthalpy of formation, Stoichiometry, Equivalence ratio, Adiabatic flame temperature, Equilibrium and dissociation, governing equations of combusting flows, modeling of a laminar diffusion flame, SCRC model for turbulent combustion, probability density function approach, eddy break up model.

CFD for radiation heat transfer: Governing equations for radiation heat transfer, Popular radiation calculation techniques using CFD, The Monte Carlo method, The discrete transfer method, Ray tracing, The discrete ordinates method.

Reference/Text Books:

1. An Introduction to Computational Fluid Dynamics, H. Versteeg & W. Malalasekra, Pearson.
2. Numerical Heat Transfer and Fluid Flow by Suhas V. Patankar, Taylor & Francis.
3. Computational Fluid Dynamics by J.C. Tannehill, D. A. Anderson and R.H. Pletcher, McGraw Hill.
4. Computational Fluid Dynamics: Principles and Applications, J. Blazek, Elsevier Science & Technology.
5. Computational Fluid Dynamics by T.J. Chung, Cambridge University Press.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining* ***four*** *questions by selecting* ***only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Semester) (THERMAL ENGINEERING)

MTME-931	GAS DYNAMICS						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3
Purpose	To equip the students to understand the basic concepts of gas flow. Also to understand the various theories related to shock waves along with sonic, subsonic and supersonic flow concepts.						
Course Outcomes							
CO 1	Enable the students to understand the various energy equations applied to compressible inviscid fluids. Also to learn the Mach number and propagation disturbance in a fluid flow.						
CO 2	To understand the flow through nozzles and diffusers. Also to study various flows through pipes.						
CO 3	To understand the concepts of shock waves. Also students are able to understand the difference between reflection, refraction and intersection of oblique shock waves.						
CO 4	To study the concepts of supersonic and subsonic flows. Also to learn wind tunnel and its instrumentation.						
CO 5	Enable the students to understand the various energy equations applied to compressible inviscid fluids. Also to learn the Mach number and propagation disturbance in a fluid flow.						

UNIT-1

General differential equations of continuity; momentum and energy applied to compressible inviscid fluids; sonic velocity; Mach number and propagation of disturbance in a fluid flow; isentropic flow and stagnation properties.

UNIT-2

Flow through nozzles and diffusers; Fanno, Rayleigh and isothermal flows through pipes.

UNIT-3

Shock Waves

Normal and oblique shocks; supersonic expansion by turning; Prandtle-Meyer function, Reflection, refraction and intersection of oblique shock waves; detached shocks.

UNIT-4

Supersonic and Subsonic Flow

Linearization and small perturbation theory; general solutions of supersonic flow; elements of supersonic thin airfoil theory; method of characteristics for solving non-linear equations; Hodograph method for mixed subsonic and supersonic flow. Wind tunnel *and its instrumentation.*

Reference/Text Books:

1. *Gas Dynamics by E. Rathakrishnan*

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2. Fundamentals of Gas Dynamics by S.M. Yahya
3. Gas Dynamics by Cambell and Jennings
4. Gas Dynamics by Becker
5. Fundamentals of Gas Dynamics by R. D. Zucker
6. Fluid Mechanics by A.K. Mohanty

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining **four** questions by selecting **only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Semester) (THERMAL ENGINEERING)

MTTH-933	COMPRESSIBLE FLOW MACHINES						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
4	-	-	4	60	40	100	3

Purpose	Students can able to understand the various fluid devices like turbine, compressors, pumps etc. Also to understand the concepts of shock waves and their properties.
Course Outcomes	
CO 1	Enable the students to understand the basic concepts of fluid machines. Also to learn the concepts of various turbines along with their general equations of power developed.
CO 2	To understand the various types of pumps along with their advantages, disadvantages and applications.
CO 3	To study the various compressors and diffusers. Also to learn the various terms and parts related to these devices.
CO 4	Enable the students to understand the basic concepts of shock waves. Also to learn the various types of shock waves through various equations.
CO 5	Enable the students to understand the basic concepts of fluid machines. Also to learn the concepts of various turbines along with their general equations of power developed.

UNIT-1

Introduction*:* Introduction to Fluid Machines, Energy Transfer in Fluid Machines, Energy Transfer-impulse and Reaction Machines, efficiencies of Fluid Machines, Principles of Similarity in Fluid Machines, Concept of Specific Speed and introduction to Impulse Hydraulic Turbine.

Turbines: Analysis of Force on the Bucket of Pelton wheel and Power Generation, Specific Speed, Governing and Limitation of a Pelton Turbine, Introduction to reaction Type of Hydraulic Turbine- A Francis Turbine, Analysis of Force on Francis Runner and Power Generation, Axial Flow machine and Draft Tube, Governing of Reaction Turbine.

UNIT-2

Pumps: Introduction to Rotodynamic Pumps, Flow and Energy Transfer in a Centrifugal Pump, Characteristics of a Centrifugal Pump, Matching of Pump and System Characteristics, Diffuser and Cavitation, Axial Flow Pump, Reciprocating Pump.

UNIT-3

Compressors: Centrifugal and Axial Flow Compressor, their characteristics.

Flow through Diffusers: Classification of diffusers, internal compression subsonic diffusers, velocity gradient, effect of friction and area change, the conical internal-compression Subsonic diffusers, external compression subsonic diffusers, supersonic diffusers, Normal shock supersonic diffusers, the converging diverging supersonic diffusers.

UNIT-4

2017-2018

Shock wave: Introduction to Compressible Flow, Thermodynamic Relations and Speed of Sound, Disturbance propagation, Stagnation and Sonic Properties, Effects of Area variation on Properties in an Isentropic Flow, choking in a Converging nozzle, Isentropic Flow Through Convergent-Divergent Duct, Normal Shock, Oblique Shock, Introduction to Expansion Wave and Prandtl Meyer Flow.

Reference/Text Books:

1. Fundamentals of Compressible Flow by S. M. Yahya, New Age International.
2. Turbines, Compressors and Fans by S.M. Yahya, Tata McGraw Hill.
3. Compressible Fluid Flow by P.H. Oosthvizen and W.E. Carscallen, McGraw Hill.

Note: The paper will have a total of ***NINE questions.*** **Question No. 1,** which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal ***weight of 12 marks.*** The student will attempt a total of ***FIVE questions***, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining **four** questions by selecting **only one question from each unit.***

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Semester) (THERMAL ENGINEERING)

MTTH-913	SYNOPSIS						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
-	-	-	10	-	100	100	-
Purpose	**The main objective of this course is to plan a research work (which includes the problem formulation/literature review, proposed objectives, proposed methodologies and references) in the field of Thermal Engineering or interrelated fields of applications.**						
	Course Outcomes						
CO 1	**To understand about the extent of past research in a particular area of interest chosen for research.**						
CO 2	**To set the objectives for the proposed problem.**						
CO 3	**To know different research methodologies related to their research area.**						
CO 4	**To prepare their plan of research work in summarize and structured way for quick review.**						

The students are required to initially work on Literature survey/ problem formulation / adopted methodology/ Industry selection/ etc. on some latest areas of Thermal Engineering or related fields.

The students will be required to submit a progress report related to their dissertation work by the end of October. The progress report will cover the following:

- The goal set for the period.
- Research papers studied.
- Methodology used in achieving the goal.
- The extent of fulfillment of the goal.

The progress report must be at least of 3-4 pages and the cover page should include the tentative topic, name of the candidate, name of the supervisor, period of progress report, signature of candidate and supervisor.

The students will be required to appear for comprehensive Seminar & Viva-voce and submit a synopsis report based on their progress related to the dissertation before 30th November. The synopsis report will be submitted in the same format as that of the thesis and will contain the following:

1. Introduction
2. Literature Survey
3. Gaps in Literature
4. Objectives of the Proposed Work
5. Methodology
6. References

* Student will choose his/her guide in the end of second semester

2017-2018

Fourth Semester

2017-2018

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (4th Semester) (THERMAL ENGINEERING)

MTTH-912	DISSERTATION						
Lecture	Tutorial	Practical	Credit	Major test	Minor test	Total	Time (Hrs.)
-	-	-	18	200	100	300	-

Purpose	**The main objective of the course is to make the students to do some good research in the field of their interests related to Thermal Engineering or interrelated fields of applications.**
	Course Outcomes
CO 1	**To understand about the extent of past research in a particular area of interest chosen for research.**
CO 2	**To make student find research gap after past literature review and formulate a problem for research.**
CO 3	**To impart knowledge to students about different research methodologies, experimental techniques while performing the research in their particular research problem.**
CO 4	**To make student understand how to articulate their research work in the form of a chapter wise organized research dissertation.**

The Students are required to undertake Analytical/Experimental/computational investigations in the field of Thermal Engg. or fields related to thermal / advanced topics etc. which have been finalized in the third semester. They would be working under the supervision of a faculty member.

The students will be required to submit a progress report duly signed by their respective supervisors to the department, related to their dissertation work in the last week of February and April. The progress report will cover the following:

- The goal set for the period.
- Research papers studied.
- Methodology used in achieving the goal.
- The extent of fulfillment of the goal.
- References

The progress report must be at least of 3-4 pages and the cover page should include the tentative topic, name of the candidate, name of the supervisor, period of progress report, signature of candidate and supervisor.

The final dissertation will be submitted in the end of semester which will be evaluated by internal as well as external examiners based upon his/her research work. At least two publications are expected before final submission of the dissertation from every student in peer reviewed referred journals from the work done by them in their dissertation.

Every dissertation will be evaluated by the joint PG evaluation Committee of the respective college, guide, an expert from the university campus and another external expert from outside the University.

2017-2018

Each year the College running the course will send the list of eligible students along with the topic name to the Chairman, Board of studies in Mechanical Engg. for nominating external examiner and examiner from university campus.

The list should be sent at least before 20th Dec. each year so that the evaluation of the thesis could be done in time. Any delay caused due to late submission of the student list along with the topics name will be the responsibility of the respective Director of the Institute.

In the absence of any examiner, the Director of the institute can nominate the alternative names on his own from the university campus and outside the university.