Sri Satya Sai University of Technology & Medical Sciences, Sehore

School of Engineering

Outcome based Curriculum for
Post Graduate Degree Courses in Engineering & Technology
Department of Mechanical Engineering

Master of Technology (Thermal Engineering)

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

Mission:

1. To imparting highest quality education to the students to build their capacity and enhancing their skills to make them globally competitive mechanical engineers.
2. To maintaining state of the art research facilities to provide collaborative environment that stimulates faculty, staff and students with opportunities to create, examine, apply and disseminate knowledge.
3. To develop alliances with world class R&D organizations, educational institutions, industry and alumni for excellence in teaching, research and consultancy practices. academic environment of excellence, leadership, ethical guidelines and lifelong learning needed for a long productive career

Program Educational Preambles (PEO's):

PEO .1: To motivate students to excel in research and to practice the technologies in the field of Thermal Engineering with Specialization in Refrigeration and Air conditioning.

PEO .2: To provide students with a solid understanding of Thermal Engineering fundamentals and applications required to solve real life problems.

PEO .3: To train students with scientific and engineering knowledge so as to comprehend, analyze, and design products and systems pertaining to Refrigeration and Air conditioning.

(4) Programme Outcomes (PO's) :

Master of Technology (Thermal Engineering)

POs.1. Mechanical Engineering knowledge: Apply the knowledge of Demonstrate knowledge of Numerical methods in solving complex advanced heat and mass transfer problems in general and Refrigeration and Air conditioning problems in particular

POs.2. Problem analysis: Able to identify, define and solve Thermal Engineering problems ,Identify, formulate, research literature, and analyze in research and development of industries to arrive at substantiated conclusions using first principles of thermal engineering .

POs.3. Design/development of solutions: Research Potential to design and conduct experiments, analyze and interpret data, processes to meet the specifications with consideration for the program execution

POs.4. Conduct investigations of complex problems: User research-based knowledge including design of Demonstrate an ability to understand thermal design systems, components orprocess as per needs and interpretation of data by condition monitoring , and synthesis of the information to provide valid conclusions.

POs.5. Modern tool usage: Demonstrate skills to use Thermal engineering tools to Create modal with the help of software and equipment to analyze problems, and apply appropriate techniques, resources, and modern technologies including prediction and implementation activities during processes with an understanding of the limitations.

POs.6. The engineer and society: Broad perspective of the research on the Thermal behavior of commercial and Industrial Refrigeration and Air conditioning systems.

POs.7. Environment and sustainability: Possess a sound understanding in the advanced Refrigeration & Air Conditioning system to resolve the issue with respect to Environment and sustainability.

POs.8. Ethics: Demonstrate a sincere attitude towards professional and ethical responsibilities

POs.9. Individual and team work: Able to works as team member and lead in different areas of advanced Refrigeration and Air-conditioning industries,

POs.10. Communication: Find out the research gap to Understand published literature and technically communicate. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

POs.11. Project management and finance: Contribution of the research in new technologies Implement cost effectiveness and improved sustainable solution .

POs.12. Life-long learning: Continue professionals development in the field of thermal engineering because learning is a lifelong activity

Program Specific Outcomes (PSOs)

Students will be able to
1. Apply the knowledge of thermal and design aspects of engineering
2. To develop the problems solving skills by imbibing different simulation and advanced mathematical tools.
3. Conduct independent research in the field of thermal Engineering by using different software tools in the area of fluid mechanics. The student shall be eligible to take up the fluid flow problems of industrial base.

PEO/PO Mapping

PEO	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
I	√	√	√	√	√	√	√	√	√	√	√	√
II			√	√			√			√	√	
III				√	√	√			√			
IV					√		√		√		√	√

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Mapping of Course Outcome and Programmer Outcome

S.no	Semester	Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
I	Semester-Ist	Advance Mathematics		*	*	*		*								*	
		Advanced Fluid Dynamics	*	*				*						*			*
		Advanced Heat Trans	*	*				*	*		*					*	*
		Advanced Internal Combustion Engine	*	*					*	*					*		
		Advanced Thermodynamics	*	*				*	*							*	
		Lab Practice-I								*	*	*	*	*	*		
		Lab Practice-II								*	*	*	*	*	*		
II	Semester-IInd	Equipment Design For Thermal Systems		*	*	*	*					*	*		*		*
		Refrigeration And Air Conditioning	*					*	*							*	
		Fundamentals Of Gas Dynamics	*	*				*	*							*	
		Thermal And Nuclear Power Plants	*	*		*		*	*					*	*		*
		Renewable Energy Engineering	*	*						*				*		*	
		Lab Practice-III								*	*	*	*	*	*	*	
		Lab Practice-IV								*	*	*	*	*	*	*	
III	Semester-IIInd	Elective I(Thermal Power Plant Engineering)	*	*				*						*	*		
		Elective I (Computational Fluid Dynamics)															
		Elective II	*	*	*		*	*						*	*		
		Elective II															
		Elective II															
		Thesis phase-1				*	*	*		*	*	*	*				*
		Seminar						*		*	*	*	*				*

IV	**Semester-IVth**	Dissertation Part- II				*	*	*		*	*	*	*			*	*

<u>Structure of Programme</u>: To fulfill the need of development of all the POs/ GAs, as per above mapping, the following semester wise programme structure are as under.

[L= Lecture, T = Tutorials, P = Practical's & C = Credits]

Total Credits*= 104

***Definition of Credit:**

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
1 Hr. Practical (P) per week	0.5 Credit
2 Hours Practical (Lab)/week	1 Credit

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Scheme of Examination

I Semester–Master of Technology–(Thermal Engineering)

S.No.	Subject Code	Subject Name	Periods per week			Credits	Maximum marks (Theory Slot)			Maximum Marks (Practical Slot)		Total Marks
			L	T	P		End Sem. *Exam*.	Tests (Two)	Assignments/ Quiz	End Sem. Practical / Viva	Practical Record/ assignment/Quiz/Presentation	
1.	MTE 101	Advance Mathematics	3	1	-	4	70	20	10	-	-	100
2.	MTE 102	Advanced Fluid Dynamics	3	1	-	4	70	20	10	-	-	100
3.	MTE 103	Advanced Heat Transfer	3	1	-	4	70	20	10	-	-	100
4.	MTE 104	Advanced Internal Combustion Engine	3	1	-	4	70	20	10	-	-	100
5.	MTE 105	Advanced Thermodynamics	3	1	-	4	70	20	10	-	-	100
6.	MTE 106	Lab practice-I	-	-	6	6	-	-	-	90	60	150
7.	MTE 107	Lab practice-II	-	-	6	6	-	-	-	90	60	150
		Total	15	5	12	32	350	100	50	180	120	800

L: Lecture- T: Tutorial- P: Practical ***w.e.f. July- 2014***

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Scheme of Examination

II Semester–Master of Technology–(Thermal Engineering)

S.No.	Subject Code	Subject Name	Periods per week			Credits	Maximum marks (Theory Slot)			Maximum Marks (Practical Slot)		Total Marks
			L	T	P		End Sem. Exam.	Tests (Two)	Assignments/ Quiz	End Sem. Practical / Viva	Practical Record/ assignment/Quiz/Presentation	
1.	MTE -201	Equipment Design For Thermal Systems	3	1	-	4	70	20	10	-	-	100
2.	MTE-202	Refrigeration And Air Conditioning	3	1	-	4	70	20	10	-	-	100
3.	MTE -203	Fundamentals Of Gas Dynamics	3	1	-	4	70	20	10	-	-	100
4.	MTE- 204	Thermal And Nuclear Power Plants	3	1	-	4	70	20	10	-	-	100
5.	MTE -205	Renewable Energy Engineering	3	1	-	4	70	20	10	-	-	100
6.	MTE -206	Lab Practice-III	-	-	6	6	-	-	-	90	60	150
7.	MTE -207	Lab Practice-IV	-	-	6	6	-	-	-	90	60	150
		Total	15	5	12	32	350	100	50	180	120	800

L: Lecture- **T: Tutorial-** **P: Practical**

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Scheme of Examination

III Semester–Master of Technology–(Thermal Engineering)

S.No.	Subject Code	Subject Name	Periods per week			Credits	Maximum marks (Theory Slot)			Maximum Marks (Practical Slot)		Total Marks
			L	T	P		End Sem. *Exam.*	Tests (Two)	Assignments/ Quiz	End Sem. Practical / Viva	Practical Record/ assignment/Quiz/Presentation	
1.	MTE 301	Elective -I	3	1	-	4	70	20	10	-	-	100
2.	MTE 302	Elective -II	3	1	-	4	70	20	10	-	-	100
3.	MTE 303	Thesis phase-1			8	8				120	80	200
4.	MTE 304	Seminar			4	4				-	100	100
		Total	6	2	12	20	140	40	20	120	180	500

Elective -I		
MTE-301	MTE-301 (A) Thermal Power Plant Engineering	MTE-302 (B) Computational Fluid Dynamics
Elective - II		
MTE-302	MTE-302 (A) Design of heat Exchangers	MTE-302 (B) Solar Energy Technology

L: Lecture- T: Tutorial- P: Practical *w.e.f July 2015*

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Scheme of Examination

IV Semester–Master of Technology–(Thermal Engineering)

S.No.	Sub Code	Subject Name	Periods per Week			Credits	Max Marks Theory			Max. Marks Practical		Total
			L	T	P		End Sem Exam	Mid Sem	TW	End Sem Practical / Viva	Practical Record/Quiz /Assignment / Presentation	
1	MTE- 401	Dissertation Part-II	-	-	20	20	-	-	-	300	200	500
TOTAL			-	-	20	20	-	-	-	300	200	500

L: Lecture- T: Tutorial- P: Practical

M.TECH.-SEMESTER-I SYLLABUS

MTE 101	**Advance Mathematics**	**3L:1T:0P**	**4 credits**	**4Hrs/Week**

Preamble:

The course is intended to :

- Introduce the Separation Variable Method and Finite Difference Methods for the solution of partial differential equations.
- Introduce Iterative methods-Jacobins method, Gauss-Seidal method.
- Introduce Fuzzy Logic and MATLAB
- Introduce Reliability

Course Outcomes:

- At the end of the course, the student should be able to :
- Apply the principles of Analytical Geometry and vector analysis to determine the equations of the straight lines and planes in Three Dimensional Space
- Apply the principles of Differential Calculus to solve a variety of practical problems in Engineering and Applied Science.
- Apply the principles of Partial Differentiation, Directional Derivatives.
- Apply the principles to solve fuzzy relation equations.
- To determine Failure rate, Hazard rate etc.

Unit 1 : Partial Differential Equation

Solution of Partial Differential Equation (PDE) by separation of variable method, Numerical solution of PDE (Laplace, Poisson's, Parabola) using finite difference Methods.

(9 Hours)

Unit 2 : Matrices And Linear System Of Equations

Solution of linear simultaneous equations by Gaussian elimination and its modification, Crout's triangularization method, Iterative methods-Jacobins method, Gauss-Seidal method, Determination of Eigen values by iteration.

(9 Hours)

Unit 3 : Calculus Of Variations

Euler-Lagrange's differential equation, The Brachistochrone problems and other applications. Isoperimetric problem, Hamilton's Principle and Lagrange's Equation, Rayleigh-Ritz method, Galerkin method.

(9 Hours)

Unit 4 : Fuzzy Logic

Operations of fuzzy sets, fuzzy arithmetic & relations, fuzzy relation equations, fuzzy logics. MATLAB introduction, programming in MATLAB scripts, functions and their application.

(9 Hours)

Unit 5 : Reliability

Introduction and definition of reliability, derivation of reliability functions, Failure rate, Hazard rate, mean time future & their relations, concepts of fault tolerant analysis.

(9 Hours)

Reference Books:

1. Higher Engineering Mathematics - by Dr. B.S. Grewal; Khanna Publishers
2. Calculus of Variations - by Elsgole; Addison Wesley.
3. Applied Numerical Methods with MATLAB by Steven C Chapra, TMH.
4. Introductory Methods of Numerical Analysis by S.S. Shastry,
5. Calculus of Variations - by Galfand & Fomin; Prentice Hall.
6. Higher Engineering Mathematics by B.V. Ramana, Tata Mc Hill.
7. Advance Engineering Mathematics by Ervin Kreszig, Wiley Easten Edd.
8. Numerical Solution of Differential Equation by M. K. Jain
9. Numerical Mathematical Analysis By James B. Scarborogh
10. Fuzzy Logic in Engineering by T. J. Ross
11. Fuzzy Sets Theory & its Applications by H. J. Zimmersoms

MTE 102	Advanced Fluid Dynamics	3L:1T:0P	4 credits	4Hrs/Week

Preamble:

The course is intended to :

- The fundamentals of theoretical fluid mechanics: fluid's characteristics and equations of motion,
- The simplifications that can be made leading to models such as incompressible flow, inviscid flow, ideal fluid flow, boundary layer flow, irrotational flow, ...
- How classical solution techniques may be used to solve a range of problems involving these simplified flow problems

Course Outcomes:

At the end of the course, the student should be able to :

- Understanding the concept of fluid and the models of fluids
- Understanding the basic physical meaning of general equations
- Understanding the concept of stream function and potential function
- Ability to derive the equation for viscous flow, including laminar flow and turbulent flow
- Ability to address such problems in engineering, and to solve the problems

UNIT 1: Non – viscous flow of incompressible Fluids: Lagrangian and Eulerain Descriptions of fluid motion- Path lines, Stream lines, Streak lines, stream tubes – velocity of a fluid particle, types of flows, Equations of three dimensional continuity equation- Stream and Velocity potential functions, **Basic Laws of fluid Flow:**Condition for irrotationality, circulation & vorticity Accelerations in Cartesystems normal and tangential accelerations, Euler's, Bernouli equations in 3D– Continuity and Momentum Equations.

(9 Hours)

UNIT 2: Principles of Viscous Flow: Derivation of Navier-Stoke's Equations for viscous compressible flow – Exact solutions to certain simple cases : Plain Poisoulle flow - Coutte flow with and without pressure gradient - Hagen Poisoulle flow - Blasius solution.

(9 Hours)

UNIT 3: Boundary Layer Concepts Prandtl's contribution to real fluid flows – Prandtl's boundary layer theory - Boundary layer thickness for flow over a flat plate – Approximate solutions – Creeping motion (Stokes) – Oseen's approximation - Von-Karman momentum integral equation for laminar boundary layer –– Expressions for local and mean drag coefficients for different velocity profiles.

(9 Hours)

UNIT 4: Introduction to Turbulent Flow: Fundamental concept of turbulence – Time Averaged Equations – Boundary Layer Equations - Prandtl Mixing Length Model - Universal Velocity Distribution Law: Van Driest Model –Approximate solutions for drag coefficients – More Refined Turbulence Models – k-epsilon model - boundary layer separation and form drag – Karman Vortex Trail, Boundary layer control, lift on circular cylinders, **Internal Flow**: Smooth and rough boundaries – Equations for Velocity Distribution and frictional Resistance in smooth rough Pipes – Roughness of Commercial Pipes – Moody's diagram.

(9 Hours)

UNIT 5: Compressible Fluid Flow – I: Thermodynamic basics – Equations of continuity, Momentum and Energy - Acoustic Velocity Derivation of Equation for Mach Number – Flow Regimes – Mach Angle – Mach Cone – Stagnation State, **Compressible Fluid Flow – II:**Area Variation, Property Relationships in terms of Mach number, Nozzles, Diffusers – Fanno and Releigh Lines, Property Relations – Isothermal Flow in Long Ducts – Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks – Supersonic Wave Drag.

(9 Hours)

Reference Books:

1. Yuman S.W – Foundations of Fluid Mechanics.
2. An Introduction to Compressible Flow – Pai.
3. Dynamics & Theory and Dynamics of Compressible Fluid Flow – Shapiro.
4. Fluid Mechanics and Machinery – D. Rama Durgaiah.(New Age Pub.)
5. Fluid Dynamics – William F. Hughes & John A. Brighton (Tata McGraw-Hill Pub.)

MTE 103	Advanced Heat Transfer	3L:1T:0P	4 credits	4Hrs/Week

Preamble:

The course is intended to :

- To apply the principles of heat transfer in the design of thermal systems .

Course Outcomes:

At the end of the course, the student should be able to :

- Mathematically model heat and mass transfer and fluid flow problems and to be able to apply different boundary conditions
- Solve the simple heat and mass transfer and fluid flow problems using analytical methods and appreciate the need of numerical methods to solve complicated problems
- Apply semi empirical formulae to determine the heat transfer parameters and use different techniques, viz., experimental, analytical and semi empirical methods to design the thermal systems.

UNIT- 1: **Brief Introduction to different modes of heat transfer**;Conduction: General heat conduction equation-Initial and Boundary conditions

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

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

(9 Hours)

UNIT - 2: Finite Difference methods for Conduction:

1D & 2D steady state and simple transient heat conduction problems – implicit and explicit methods.

Forced Convection: Equations of Fluid Flow – Concepts of Continuity, momentum equations – Derivation of Energy equation - Methods to determine heat transfer coefficient: Analytical Methods - Dimensional Analysis and concept of exact solution. Approximate Method – Integral analysis.

(9 Hours)

UNIT - 3: External flows:

Flow over a flat plate: Integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometrics for Laminar and Turbulent flows.

Internal flows: Fully developed flow: Integral analysis for laminar heat transfer coefficient – Types of flow – Constant Wall Temperature and Constant Heat Flux Boundary Conditions - Hydrodynamic & thermal entry lengths; use of empirical correlations.

(9 Hours)

UNIT - 4: Free convection:

Approximate analysis on laminar free convective heat transfer – Boussinesque Approximation - Different geometries – combined free and forced convection

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

(9 Hours)

UNIT - 5: Radiation Heat Transfer:

Radiant heat exchange in grey, non-grey bodies, with transmitting, reflecting and absorbing media, specular surfaces, gas radiation – radiation from flames.

Mass Transfer: Concepts of mass transfer – Diffusion & convective mass transfer Analogies – Significance of non-dimensional numbers.

(9 Hours)

Reference Books :

1. Fundamentals of Heat & Mass Transfer – Incroera Dewitt (Jhon Wiley)
2. Heat Transfer : A basic approach – Yunus Cangel (MH)
3. Heat & Mass Transfer – D.S. Kumar
4. Heat Transfer – P.K. Nag(TMH)
5. Principle of Heat Transfer – Frank Kreith & Mark.Bohn.
6. Convective Heat and Mass Transfer / W.M.Kays & M.E.Crawford(TMH)
7. Radiation Heat Transfer –G.M.Sparrow& R.D.Cess
8. Thermal Radiation heat transfer – R.Siegel & J.R.Howell
9. Radiation Heat Transfer – H.G.Hottel & A.F.Sarofim

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Master of Technology (Thermal Engineering)

MTE-104	Advanced Internal Combustion Engines	3L:1T:0P	4 credits	4Hrs/Week

Preamble:

The course is intended to :

- Analyze engine cycles and the factors responsible for making the cycle different from the Ideal cycle.
- Apply principles of thermodynamics, fluid mechanics, and heat transfer to influence the engine's performance
- Understand the delay period and fuel injection system
- Become aware of the relevance of environmental and social issues on the design process of internal combustion engines

Course Outcomes:

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

- Apply thermodynamic analysis to IC engines and describe combustion phenomena in spark ignition and compression ignition engines.
- Describe the working of major systems used in conventional and modern engines.
- Summarize the methods used to improve engine performance and estimate performance parameters.
- Describe engine emission control techniques and implement viable alternate fuels

UNIT - 1: Introduction – Historical Review – Engine Types – Design and operating Parameters.

Cycle Analysis: Thermo-chemistry of Fuel – Air mixtures, properties – Ideal Models of Engine cycles – Real Engine cycles - differences and Factors responsible for – Computer Modeling.

(9 Hours)

UNIT - 2: Gas Exchange Processes: Volumetric Efficiency – Flow through ports – Supercharging and Turbo charging.

Charge Motion: Mean velocity and Turbulent characteristics – Swirl, Squish – Pre-chamber Engine flows.

(9 Hours)

UNIT - 3: Engine Combustion in S.I engines: Combustion and Speed – Cyclic Variations –

Ignition – Abnormal combustion Fuel factors, MPFI, SI engine testing.

Combustion in CI engines: Essential Features – Types off Cycle. Pr. Data – Fuel Spray Behavior – Ignition Delay – Mixing Formation and control, Common rail fuel injection system

(9 Hours)

UNIT - 4: Pollutant Formation and Control: Nature and extent of problems – Nitrogen Oxides, Carbon monoxide, unburnt Hydrocarbon and particulate – Emissions – Measurement – Exhaust Gas Treatment, Catalytic converter, SCR, Particulate Traps, Lean, NOx, Catalysts.

(9 Hours)

UNIT - 5: Alternet fuel & Supply Systems Fuel supply systems for S.I. and C.I engines to use gaseous fuels like LPG, CNG and Hydrogen.

Modern Trends in IC Engines

- Lean Burning and Adiabatic concepts
- Rotary Engines.
- Modification in I.C engines to suit Bio - fuels.
- HCCI and GDI concepts

\- **(9 Hours)**

References Books:

1. I.C. Engines Fundamentals/Heywood/Mc Graw Hill
2. The I.C. Engine in theory and Practice Vol.I / Teylor / IT Prof. And Vol.II
3. I.C. Engines: Obert/Int – Text Book Co.
4. I.C. Engines: Maleev
5. Combustion Engine Processes: Lichty
6. I.C. Engines: Ferguson
7. Scavenging of Two – stroke Cycle Engines – Switzer.
8. I.C.Engines by V.Ganesan

MTE-105	**Advanced Thermodynamics**	**3L:1T:0P**	**4 credits**	**4Hrs/Week**

Preamble:

The course is intended to:

- Provide analytical methods for the determination of the direction of processes from the first and second laws of thermodynamics and to Introduce methods in using equations of potentials, availability, and excergy for thermodynamic analysis
- Gain the knowledge on non-reactive mixture properties , Psychometric Mixture properties and psychometric chart and Air conditioning processes
- Develop the ability of analyzing vapor and Gas power cycles

Course Outcomes:

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

- Explain basic thermodynamic concepts and laws
- Describe the concepts entropy and excergy and their use in analyses of thermal energy systems
- Analyze power plants, refrigeration plants and thermal/chemical installations
- Evaluate means for minimizing excergy losses in selected processes
- Use advanced thermodynamics on a research case

Unit - 1:

Review of Thermo dynamic Laws and Corollaries – Transient Flow Analysis – Second law of thermodynamics – Entropy - Availability and unavailability – Irreversibility – Thermo dynamic Potentials – Maxwell Relations – Specific Heat Relations – Mayer's relation - Evaluation of Thermodynamic properties of working substance.

(9 Hours)

Unit - 2:

P.V.T. surface – Equations of state – Real Gas Behaviour – Vander Waal's equation - Generalised compressibility Factor – Energy properties of Real Gases – Vapour pressure – Clausius – Clapeyron Equation – Throttling – Joule – Thompson coefficient.Non-reactive Mixture of perfect Gases – Governing Laws – Evaluation of properties – Pychrometric Mixture properties and psychrometric chart – Air conditioning processes – Cooling Towers – Real Gas Mixture.

(9 Hours)

Unit – 3 :

Combustion – Combustion Reactions – Enthalpy of Formation – Entropy of Formation – Reference Levels for Tables – Energy of formation – Heat of Reaction – Aiabatic flame Temperature General product – Enthalpies – Equilibrium. Chemical Equilibrium of Ideal Gases – Effects of Non-reacting Gases Equilibrium in Multiple Reactions. The vant Hoff's Equation. The chemical potential and phase Equilibrium – The Gibbs phase Rule.

(9 Hours)

Unit - 4:

Power cycles, Review Binary vapour cycle, co-generation and Combined cycles – Second law analysis of cycles – Refrigeration cycles. Thermo Dynamics off irreversible processes – Introduction – phenomenological laws – Onsagar Reciprocity Relation – Applicability of the phenomenological Relations – Heat Flux and Entropy Production – Thermo dynamic phenomena – Thermo electric circuits.

(9 Hours)

Unit - 5:

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

(9 Hours)

References Books:

1) Basic and Applied Thermodynamics, P.K. Nag, TMH
2) Thermo dynamics / Holman, Mc Graw Hill
3) Thermo dynamics / Doolittle – Messe
4) Thermo dynamics / Sonnatag & Van Wylen
5) Irreversible Thermo Dynamics / HR De Groff.
6) Engg. Thermo dynamics /PL.Dhar

Master of Technology (Thermal Engineering)

MTE -106	LAB PRACTICE-I	L:T:6P	6 credits	6Hrs/Week

Preamble:

The course is intended to :

- The fundamentals of theoretical fluid mechanics: fluid's characteristics and equations of motion,
- The simplifications that can be made leading to models such as incompressible flow, inviscid flow, ideal fluid flow, boundary layer flow, irrotational flow, ...

Course Outcomes:

At the end of the course, the student should be able to :

- Mathematically model heat and mass transfer and fluid flow problems and to be able to apply different boundary conditions
- Solve the simple heat and mass transfer and fluid flow problems using analytical methods and appreciate the need of numerical methods to solve complicated problems
- Understanding the concept of stream function and potential function
- Ability to derive the equation for viscous flow, including laminar flow and turbulent flow
- Ability to address such problems in engineering, and to solve the problems

List of Experiments:

1. Conduction through a rod to determine thermal conductivity of material

2. Parallel flow and counter flow heat exchanger effectiveness and heat transfer rate

3. Experimental determination of Stefen-Boltzman constant

4. To determine the hydraulic coefficients (Cc , Cd and Cv) of an orifice.

5. To determine the coefficient of discharge of a mouth piece.

6. To study the variation of friction factor for pipe flow

MTE - 107	LAB PRACTICE-II	L:T:6P	6 credits	6Hrs/Week

Preamble:

The course is intended to :

- Analyze engine cycles and the factors responsible for making the cycle different from the Ideal cycle.
- Apply principles of thermodynamics, fluid mechanics, and heat transfer to influence the engine's performance
- Understand the delay period and fuel injection system

Course Outcomes:

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

- Explain basic thermodynamic concepts and laws
- Describe the concepts entropy and excergy and their use in analyses of thermal energy systems
- Analyze power plants, refrigeration plants and thermal/chemical installations
- Summarize the methods used to improve engine performance and estimate performance parameters.
- Describe engine emission control techniques and implement viable alternate fuels

List of Experiments:

1. To find mechanical equivalent of heat using Joules apparatus

2. To study working of impulse and reaction steam turbine.

3. To study working of Gas turbines .

4. Load test on Petrol Engine

5. Heat Balance of SI engine

M.TECH.-SEMESTER-II SYLLABUS

MTE 201	Equipment Design For Thermal Systems	3L:1T:0P	4 credits	4Hrs/Week

Preamble:

The course is intended to
- Design and analyse the heat exchangers parallel flow, counter flow, multiphase and, cross flow heat exchanger
- Design and analyse the Shell and tube heat exchanger
- Enable to carryout the performance of heat exchanger with the extended surfaces.
- Design and analyse the cooling towers.

Course Outcomes:

At the end of the course the learners will be able to
- Design and analyse the parallel flow, counter flow, multiphase and, cross flow heat exchangers
- Developed the Shell and tube heat exchanger
- Optimise the performance of heat exchanger.
- Design and analyse the cooling towers

Unit - 1: Classification of heat exchangers: Introduction, Recuperation & Regeneration – Tubular heat exchangers: double pipe, shell & tube heat exchanger, Plate heat exchangers, Casketed plate heat exchanger, spiral plate heat exchanger, Lamella heat exchanger, extended surface heat exchanger, Plate fin, and Tubular fin.

Basic Design Methods of Heat Exchanger: Introduction, Basic equations in design, Overall heat transfer coefficient – LMTD method for heat exchanger analysis – parallel flow, counter flow, multiphase, cross flow heat exchanger design calculations.

(9 Hours)

Unit - 2: Shell & Tube Heat Exchangers: Tube layouts for exchangers, baffle Heat exchangers, calculation of shell and tube heat exchangers – shell side film coefficients, Shell side equivalent diameter, the true temperature difference in a 1-2 heat exchanger, influence of approach temperature on correction factor, shell side pressure drop, tube side pressure drop, Analysis of performance of 1-2 heat exchanger, and design calculation of shell & tube heat exchangers. Flow arrangements for increased heat recovery, the calculations of 2-4 exchangers.

(9 Hours)

Unit - 3: Vaporizers, Evaporators and Reboilers: Vaporizing processes, forced circulation vaporizing exchangers, natural circulation vaporizing exchangers, calculations of a reboiler.

(9 Hours)

Unit – 4: Extended Surfaces: Longitudinal fins, weighted fin efficiency curve, calculation of a double pipe fin efficiency curve, and calculation of a double pipe finned exchanger, calculation of a longitudinal fin shell and tube exchanger.

(9 Hours)

Unit - 5: Direct Contact Heat Exchanger: Cooling towers, relation between wet bulb & dew point temperatures, the Lewis number, and classification of cooling towers, cooling tower internals and the roll of fill, Heat balance, heat transfer by simultaneous diffusion and convection. Analysis of cooling tower requirements, Design of cooling towers, Determination of the number of diffusion units, calculation of cooling tower performance.

(9 Hours)

Reference Books :

1. Process Heat Transfer – D.Q. Kern, TMH.
2. Cooling Towers by J.D. Gurney
3. Heat Exchanger Design – A.P.Fraas and M.N. Ozisick. John Wiely & sons, New York.

MTE 202	**Refrigeration And Air Conditioning**	**3L:1T:0P**	**4 credits**	**4Hrs/Week**

Preamble:

The course is intended to:

- Apply the principles of Thermodynamics to analyse different types of refrigeration and air conditioning systems experimentally and evaluate performance parameters under actual conditions in relation to the ideal conditions.

Course Outcomes:

At the end of the course, the student should be able to:

- Differentiate between different types of refrigeration systems with respect to application as well as conventional and unconventional refrigeration systems
- Thermodynamically analyze refrigeration and air conditioning systems and evaluate performance parameters based on the measured properties by using property charts
- Simulation and Analysis of Refrigeration and Air conditioning systems and Components

Unit – 1: Vapour Compression Refrigeration: Performance of Complete vapor compression system. **Components of Vapor Compression System:** The condensing unit – Evaporators – Expansion valve – Refrigerants – Properties – ODP & GWP - Load balancing of vapor compression Unit.

Compound Compression: Flash inter-cooling – flash chamber – Multi-evaporator & Multistage systems.

(9 Hours)

Unit – 2: Production of low temperature – Liquefaction system ;Cascade System – Applications.– Dry ice system.

Vapor absorption system – Simple and modified aqua – ammonia system – Representation on Enthalpy –Concentration diagram. Lithium – Bromide system Three fluid system – HCOP.

(9 Hours)

Unit – 3: Air Refrigeration: Applications – Air Craft Refrigeration -Simple, Bootstrap, Regenerative and Reduced ambient systems – Problems based on different systems.

Steam Jet refrigeration system Representation on T-s and h-s diagrams – limitations and applications.

Unconventional Refrigeration system – Thermo-electric – Vortex tube & Pulse tube – working principles.

(9 Hours)

Unit – 4: Air –conditioning: Psychrometric properties and processes – Construction of Psychrometric chart. Requirements of Comfort Air –conditioning – Thermodynamics of human body – Effective temperature and Comfort chart – Parameters influencing the Effective Temperature. Summer , Winter and year round air – conditioning systems. Cooling load Estimation: Occupants, equipments, infiltration, duet heat gain fan load, Fresh air load.

(9 Hours)

Unit – 5: Air –conditioning Systems: Re-circulated air with & without bypass, with reheat systems – Calculation of Bypass Factor, ADP, RSHF, ESHF and GSHF for different systems.
Components: Humidification and dehumidification equipment – Systems of Air cleaning – Grills & diffusers – Fans & blowers – Measurement & control of Temperature & Humidity.

Reference Books :

1) Refrigeration and Air Conditioning :Manohar Prasad
2) Refrigeration and Air Conditioning : Stoecker – Mc Graw Hill
3) Principles of Refrigeration – Dossat (Pearson)
4) Refrigeration and Air Conditioning : Ananthanarayana (TMH)
5) Refrigeration and Air Conditioning : Jordan and – Prentice Hall, Preister
6) Refrigeration and Air Conditioning : Dossat – Mc Graw Hill
7) Thermal Environmental Engg. : Threlkeld – Van Nostrand
8) Refrigeration and Air Conditioning : Ballany – Khanna
9) Refrigeration and Air Conditioning : SC Jain S.Chand and Co.

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Department of Mechanical Engineering

Master of Technology (Thermal Engineering)

MTE 203	Fundamentals Of Gas Dynamics	3L:1T:0P	4 credits	4Hrs/Week

Preamble:

- The series which stress the more fundamental aspects of the various phenomena that make up the broad field of aeronautical science.
- The aerodynamicist and gas dynamicist will find both the classical and the important new concepts of gas dynamics presented in an informative and stimulating manner.
- Development of basic algorithms in computational fluid dynamics and related fields (computational aero-acoustics, electromagnetics, plasma physics and others)
- Development of parallel codes to solve large-scale problems in aerodynamics

Course Outcomes:

Upon successful completion of the course, students should be able to

- Understand fundamental of gas dynamics
- Understand working of compressors, turbines etc.
- Understand working of jet propulsion cycles.
- Able to do analysis of jet propulsion systems.

UNIT 1:

Fundamental Aspects of Gas Dynamics: Introduction, Isentropic flow in a stream tube, speed of sound, Mach waves; One dimensional Isentropic Flow: Governing equations, stagnation conditions, critical conditions, maximum discharge velocity, isentropic relations ; Normal Shock Waves: Shock waves, stationary normal shock waves, normal shock wave relations in terms of Mach number.

(9 Hours)

UNIT 2:

Oblique Shock Waves: Oblique shock wave relations, reflection of oblique shock waves, interaction of oblique shock waves, conical shock waves; Expansion Waves: Prandtl-Meyer flow, reflection and interaction of expansion waves, flow over bodies involving shock and expansion waves ; Variable Area Flow: Equations for variable area flow, operating characteristics of nozzles, convergent-divergent supersonic diffusers ; Adaiabatic Flow in a Duct with Friction: Flow in a constant area duct, friction factor variations, the Fanno line.

(9 Hours)

UNIT 3:

Flow with Heat addition or removal: One-dimensional flow in a constant area duct neglecting viscosity, variable area flow with heat addition; one-dimensional constant area flow with both heat exchanger and friction ; Generalized Quasi-One-Dimensional Flow: Governing equations and influence coefficients, solution procedure for generalized flow with and without sonic point.

(9 Hours)

UNIT 4:

Two-Dimensional Compressible Flow: Governing equations, vorticity considerations, the velocity potential, linearized solutions, linearized subsonic flow, linearized supersonic flow, method of characteristics.

(9 Hours)

Reference Books :

P. H. Oosthuizen and W. E. Carscallen. Compressible Fluid Flow. NY, McGraw-Hill, 1997.
M. A. Saad, Compressible Fluid Flow. 2nd ed. Upper Saddle River, NJ: Prentice-Hall, 1993.
F. M. White, Viscous Fluid Flow. 2nd ed. New York: McGraw-Hill, 1991.
A. H. Shapiro, Compressible Fluid Flow 1 and 2. Hoboken NJ: John Wiley.

MTE 204	Thermal And Nuclear Power Plants	3L:1T:0P	4 credits	4Hrs/Week

Preamble:

The course is intended to

- Provide in awareness about resources of energies available in India for Power Production by Thermal and Nuclear Processes.
- Understand and know the requirements for a Thermal Power Plant and Nuclear Power Plant, from sources to consumption and economics of power plants.
- Study and learn the processes and cycles followed in Thermal Power Plants and nuclear power plants and components used in the power plants.

Course Outcomes:

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

- Gain the knowledge about resources of energies available in India for Power Production by Thermal and Nuclear Processess.
- Analyze the processes and cycles followed in Thermal Power Plants and nuclear power plants and components used in the power plants and identify the losses to get better efficiency.
- Apply the knowledge gained by analyzing the steam power plants, steam generators and gas turbine power plants, to improve the efficiency and reduce the thermal losses.

Unit - 1: Introduction – Sources of Energy, types of Power Plants, Direct Energy Conversion System, Recent developments in Power Generation. Steam Power Plants: Modern Coal-fired Steam Power Plants, Power Plant cycles, Combustion Equipment. Steam Generators: Types, Performance of Boilers, Cooling Towers, Steam Turbines, Compounding of Turbines, Condensers.

(9 Hours)

Unit - 2: **Gas Turbine Power Plant**: Co-generation, Combined cycle Power Plants, Analysis, Waste-Heat Recovery, IGCC Power Plants, Fluidized Bed Combustion.

(9 Hours)

Unit -3: Nuclear Power Plants: Nuclear Reactors, Classification – Types of Reactors, Methods of enriching Uranium, Thorium nuclear reactors, Nuclear Power Plants Safety: By-Products of Nuclear Power Generation, Economics of Nuclear Power Plants, Nuclear Power Plants in India, Future of Nuclear Power.

(9 Hours)

Unit -4: Economics of Power Generation: Factors affecting the economics, Load Factor, Utilization factor, Performance and Operating Characteristics of Power Plants. Economic Load Sharing, Depreciation, Energy Rates, Specific Economic energy problems.

(9 Hours)

Unit - 5: Power Plant Instrumentation: Classification, Pressure measuring instruments, Temperature measurement and Flow measurement. Analysis of Combustion gases, Methods to Control.

(9 Hours)

Reference Books :

1. Power Plant Engineering / P.K. Nag / TMH.
2. Power Plant Engineering / R.K. Rajput / Lakshmi Publications.
3. Power Plant Engineering / P.C.Sharma / Kotaria Publications.
4. Power Plant Technology / Wakil.

MTE 205	Renewable Energy Engineering	3L:1T:0P	4 credits	4Hrs/Week

Preamble:

The course is intended to:

- Introduce to the technology of renewable sources of energy
- Learn about the solar radiation, its applications and radiation measuring instruments
- Learn about the various types of geothermal resources and its applications
- Study the biomass energy resources , bio-mass systems

Course Outcomes:

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

- Identify the renewable energy sources and their utilization
- Understand the basic concepts of the solar radiation and analyze the solar Thermal systems for their utilization
- Understand the principle of working of solar cells and their modern
- Manufacturing techniques
- Understand the concepts of the ocean thermal energy conversion systems and their applications

Unit – 1: Introduction – Energy Scenario, Survey of Energy Resources, Classification, Need for Non-Conventional Energy Resources. Solar Energy, Solar radiation, Radiation measuring instruments. **Solar Energy Applications:** Solar water Heating, space heating – active and passive heating – energy storage – selective surface – solar stills and ponds – solar refrigeration – photovoltaic generation.

(9 Hours)

Unit - 2: Geothermal Energy: Structure of Earth – Geothermal Regions – Hot springs – Hot Rocks – Hot Aquifers – Analytical Methods to estimate Thermal Potential – Harnessing Techniques – Electricity Generating Systems.

(9 Hours)

Unit - 3: Hydrogen Fuel – Production methods – Properties – I.C. Engines Applications – Utilization Strategy – Performances. Advantages and disadvantages.

(9 Hours)

Unit – 4: Energy from Oceans: Tidal Energy; Tides – Diurnal and Semi – Diurnal Nature – Power from Tides. Wave Energy; Waves – Theoretical Energy Available – Calculation of period and phase velocity of waves – wave power systems – submerged devices. Ocean Thermal Energy: principles – Heat Exchangers – Pumping requirements – Practical Considerations

(9 Hours)

Unit – 5: Wind Energy: Wind – Beaufort number – characteristics – wind energy conversion systems – types – Betz model – Interference Factor – Power Coefficient – Torque Coefficient and thrust coeff.- Lift machines and drag machines – matching – electricity generation.

(9 Hours)

Reference Books :

1. Renewable Energy Resources / John Twidell & Tony Weir
2. Biological Energy Resources / Malcolm Flescher & Chrris Lawis
3. Renewable Energy Resources – Basic Principles and Applications – G.N.Tiwari and M.K.Ghosal, Narosa Pub

MTE -206	**LAB PRACTICE-III**	**L:T:6P**	**6 credits**	**6Hrs/Week**

Preamble:

The course is intended to:

- Apply the principles of Thermodynamics to analyse different types of refrigeration and air conditioning systems experimentally and evaluate performance parameters under actual conditions in relation to the ideal conditions.

Course Outcomes:

At the end of the course, the student should be able to:

- Differentiate between different types of refrigeration systems with respect to application as well as conventional and unconventional refrigeration systems
- Thermodynamically analyze refrigeration and air conditioning systems and evaluate performance parameters based on the measured properties by using property charts
- Design and analyse the parallel flow, counter flow, multipass and, cross flow heat exchangers

List of Experiments:

1. Experimentation on Cold Storage of Calculate COP & Heat Loss.
2. Experimentation on Vapor compression Air Conditioning test rig
3. Study of multistage Compressor.
4. Experimental determination of Stefen-Boltzman constant5. Parallel flow and counter flow heat exchanger effectiveness and heat transfer rate

MTE - 207	LAB PRACTICE-IV	L:T:6P	6 credits	6Hrs/Week

Preamble:

The course is intended to

Preamble:

- To understand fundamental of gas dynamics
- To know types of compressors and turbines used in aircrafts
- Study and learn the processes and cycles followed in Thermal Power Plants and nuclear power plants and components used in the power plants.
- Study the biomass energy resources , bio-mass systems

Course Outcomes:

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

- Understand fundamental of gas dynamics
- Understand working of compressors, turbines etc.
- Analyse the processes and cycles followed in Thermal Power Plants and nuclear power plants and components used in the power plants and identify the losses to get better efficiency.

List of Experiments:

1. Study of Induced draft/forced and balanced draft by chimney.
2. Study of different types of steam turbines.
3. To study working of Gas turbines .
4. To study Recent developments in Power Generation
5. To study Types of Reactors

M.TECH.-SEMESTER-III SYLLABUS

MTE-301	**Thermal Power Plant Engineering**	**3L:1T:0P**	**4 credits**	**4Hrs/Week**

Preamble:

The course is intended to :

- Provide in awareness about resources of energies available in India for Power Production by Thermal Processes.
- Understand and know the requirements for a Thermal Power Plant, from sources to consumption and economics of power plants.
- Study and learn the processes and cycles followed in Thermal Power Plants and components used in the power plants
- Gain the knowledge on steam power plants, steam generators and gas turbine power plants, their analyses on fuel and fluidized bed combustion, ash handling systems,

Course Outcomes:

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

- Describe how fission is accomplished and the basics of how a nuclear reactor produces energy
- Discuss the thermal cycle and describe heat transfer and fluid flow
- Identify the major components of a thermal power plant including generators, turbines, and cooling systems

UNIT I

Conventional thermal power plants, super-critical power plants and its principles of working, performance curves and flow diagrams. Type of boiler Working and Principle.

(9 Hours)

UNIT II

Power plant components: Fuel and ash handling, pulverized fuel firing burners, dust handling, fluidized bed combustion. Radiant super heaters and re-heaters, economizer and pre-heaters, combustion and furnace design, boiler water supply and treatment. Drat and arrangement of draft fans, different types of cooling systems, open closed, mixed and dry cooling tower systems, air cooled condensers. Ejector and vacuum pumps, feed heating systems, heaters, evaporators and de-airator, feed line protection, boiler feed pumps, different type of drives for it, steam turbine driven feed pumps.

(9 Hours)

Unit III

Plant instrumentation for thermal power plants, need and importance, distributed and centralized, pneumatic and electro-mechanical transducers and controllers, distributed computer control. Piping and insulation: design and layout of ducting for air fuel, gases and pulverized fuels, selection of piping, pipe flexibility analysis, Various control valves and actuators. Insulation optimum thickness and costs.

(9 Hours)

Unit IV

Installation, commissioning and operation: Preliminary performance checks and acceptance test for various components, heat balance of items and entire plant. Starting loading and normal operation checks, maintenance logging, parallel operations, droop setting, performance analysis, maintenance, safety and pollution controls.

(9 Hours)

UNIT V

Plant Management: Preparing specifications and contract documents, guarantee. Training of power plant personnel, safety, and seismic analysis. Purchase and contract for fuel supplies.

(9 Hours)

Reference;

1. Power Plant Engineering, F T Morse
2. Power Plant Engineering, P K Nag
3. Power Plant Engineering, Arora and Domkundwar
4. Power Plant Engineering R.K.Rajput

MTE- 301 (B)	**COMPUTATIONAL FLUID DYNAMICS**	**3L:1T:0P**	**4 credits**	**4Hrs/Week**

Preamble:

- Automotive companies for Aerodynamics, Heat Transfer, Combustion etc.,
- Defence labs like DRDO, CVRDE etc.,
- Space labs like VSSC, LPSC etc., under ISRO
- Aerospace/Aeronautical Labs/R&D like HAL, NAL, ADA, ADE, Airbus, Textron, Boring, Saran etc.,
- Wind Energy companies like Vistas, Games etc.
- Apply the principles of Heat Transfer and Fluid Mechanics to solve simple heat transfer and fluid flow problems using different numerical techniques

Course Outcomes:

At the end of the course, the student should be able to:

- Differentiate between different types of Partial Differential Equations and to be able to apply appropriate numerical techniques
- Solve the simple heat transfer and fluid flow problems using different numerical techniques
- Understand and to appreciate the need for validation of numerical solution

UNIT – I INTRODUCTION: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations.

Solution methods: Solution methods of elliptical equations — finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

(9 Hours)

UNIT – II HYPERBOLIC EQUATIONS: explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

(9 Hours)

UNIT – III FORMULATIONS OF INCOMPRESSIBLE VISCOUS FLOWS:

Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.**Treatment of compressible flows:** potential equation, Euler equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

(9 Hours)

UNIT – IV FINITE VOLUME METHOD:Finite volume method via finite difference method, formulations for two and three-dimensional problems.

(9 Hours)

UNIT – V STANDARD VARIATIONAL METHODS: Linear fluid flow problems, steady state problems, Transient problems.

(9 Hours)

Reference Books:

1. Computational Fluid Dynamics by Hoffman and Chiang, Engg Education System

2. Computational Fluid Dynamics by Anderson, TMH

3. Computational Methods for Fluid Dynamics by Ferziger, Peric, Springer

4. Computational Fluid Dynamics by T.J. Chung, Cambridge University

5. Computational Fluid Dynamics by A Practical Approach – Tu, Yeoh, Liu, Elsevier

6. Text Book of Fluid Dynamics by Frank Chorlton, CBS Publishers

MTE-302 (A)	Design of heat Exchangers	3L:1T:0P	4 credits	4Hrs/Week

Preamble:

The course is intended to:

- Design and analyse the heat exchangers parallel flow, counter flow, multipacks and, cross low heat exchanger
- It provides exposure to different kind of heat exchanger, their working and selection for a given application.
- Students will come to know about different techniques of heat exchanger analysis.
- Student will be able to learn construction and thermal design methodology of shell and tube, Plate and compact heat exchanger

Course Outcomes:

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

- Have knowledge of different techniques of heat exchanger analysis and be aware of common heat exchangers with their constructions, working principles and performance parameters,
- Understand the significance of contents of the course for the design and development of heat exchangers.
- Apply their knowledge for thermal design of a heat exchanger such as shell and tubes, compact and plate heat exchanger,
- Analyze an existing heat exchanger with reference to rating and sizing.

UNIT 1 TYPES OF HEAT EXCHANGERS:Definitions & quantitative relationship, Basic design methods for heat exchanger- Design of shell and tube type heat exchanger, Recent developments in heat exchangers.

(9 Hours)

UNIT 2 ANALYTICAL-Numerical solution Procedures, Fouling factors, Correction factors Computerized methods for design and analysis of heat exchanger. Performance enhancement of heat exchanger, fouling of heat exchanger. Testing, evaluation and maintenance of heat exchanger.

(9 Hours)

UNIT 3-Thermal & hydraulic design of Commonly used heat exchangers : Double pipe heat exchangers , , condensers, Evaporators, Cooling and dehumidifying coils, Cooling towers, Evaporative condensers , design of air washers , desert coolers.

(9 Hours)

UNIT 4 REVIEW OF MECHANICAL DESIGN- TEMA Codes Materials of Construction , corrosion damage , Testing and inspection . Power plant heat exchanger, heat exchanger for heat recovery at low, medium and high temperatures.

(9 Hours)

UNIT 5 Heat Pipe: Basics & its mathematical model , micro Heat Exchangers. Furnaces, Radiative heat exchangers ,Use of software in heat exchanger design.

(9 Hours)

Reference Books:

1.Compact Heat Exchangers Kays and London, TMH

2.Heat Exchangers- Thermal Hydraulic fundamentals and design, Kokac, TMH

3.Extended Surface Heat Transfer, D Q Kern, A D Kraus, TMH.

4.Tubular Exchanger Manufacturer Association (TEMA), and other codes.

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Department of Mechanical Engineering

Master of Technology (Thermal Engineering)

MTE -302 (B)	**SOLAR ENERGY TECHNOLOGY**	**3L:1T:0P**	**4 credits**	**4Hrs/Week**

Preamble:

The course is intended to

- Have a good understanding of renewable energy systems, its components and interactions between the components. This includes all renewable energy technologies, different storage technologies, distribution grid, smart grid including sensors. Regulation and control, and both "stand alone" systems and large integrated distribution systems.
- Have a good understanding of national and international regulations and framework conditions for renewable energy systems. This also includes different price models and actions.
- Have profound knowledge in a special field such as solar energy, storage, smart grid.

Course outcomes:

After studying this course, you should be able to:

- Explain the principles that underlie the ability of various natural phenomena to deliver solar energy
- Outline the technologies that are used to harness the power of solar energy
- Discuss the positive and negative aspects of solar energy in relation to natural and human aspects of the environment.

UNIT – I Introduction: Solar energy option, specialty and potential – Sun – Earth – Solar radiation, beam and diffuse – measurement – estimation of average solar radiation on horizontal and tilted surfaces – problems – applications. Capturing solar radiation – physical principles of collection – types – liquid flat plate collectors – construction details – performance analysis – concentrating collection – flat plate collectors with plane reflectors – cylindrical parabolic collectors – Orientation and tracking – Performance Analysis.

(9 Hours)

UNIT – II DESIGN OF SOLAR WATER HEATING SYSTEM AND LAYOUT

Power generation – solar central receiver system – Heliostats and Receiver – Heat transport system-solar distributed receiver system – Power cycles, working fluids and prime movers, concentration ratio.

(9 Hours)

UNIT – III THERMAL ENERGY STORAGE: Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage – working principle – construction – application and limitations.

Other solar devices – stills, air heaters, dryers, Solar Ponds & Solar Refrigeration, active and passive heating systems.

(9 Hours)

UNIT – IV DIRECT ENERGY CONVERSION: solid-state principles – semiconductors – solar cells – Solar cell energy conversion efficiency, I-V characteristics, effect of variation of solar insulation and temperature, losses. Semiconductor properties, energy levels, basic equations. Solar cell, p-n junction, structure. Solar PV power plants. performance – modular construction – applications. conversion efficiencies calculations.

(9 Hours)

UNIT – V ECONOMICS: Principles of Economic Analysis .Increase in value creation. Funding and sponsoring facilities, international organizations, national possibilities. Incentives, subsidies and feed-in traffic. – Discounted cash flow – Solar system – life cycle costs – cost benefit analysis and optimization – cost based analysis of water heating and photo voltaic .Design of solar PV systems. applications. Present & future sanerio for solar energy.

(9 Hours)

Reference Books:

1. Principles of solar engineering/ Kreith and Kerider/Taylor and Franscis/2nd edition

2. Solar energy thermal processes/ Duffie and Beckman/John Wiley & Sons
3. Solar energy: Principles of Thermal Collection and Storage/ Sukhatme/TMH/2nd edition
4. Solar energy/ Garg/TMH
5. Solar energy/ Magal/Mc Graw Hill
6. Solar Thermal Engineering Systems / Tiwari and Suneja/Narosa

MTE – 302 (C)	Modelling and Analysis Of I.C. Engine	4 credits	4Hrs/Week	3L:1T:0P

Preamble:

The course is intended to

- Understand the flame temperature, the different types of reaction occurring in an engine, while combustion.
- Understand the simulation in an IC engine with fuel air as working medium.
- Know about how the pressure is being getting developed in an engine.
- Understand the simulation of a IC engine.
- Understand the simulation in an IC engine with fuel air as working medium

Course Outcomes:

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

- To impart knowledge on simulation of various engine processes .
- To learn the simulation of engine combustion based on law of thermodynamics.
- To learn simulation of engine trouble shooting.
- Modeling of Carburetion and injection process

Unit 1 Basic simulation modeling : Nature of simulation, so the system concept, system environment, continuum and discrete system , system modeling, Types of models like static physical, Dynamic physical and mathematical models, principle and in modeling block building relevance, accuracy and aggregation.

(9 Hours)

Unit 2 Probability Concept in Simulation:Stochastic variables, discrete and continuum probability function, Measures of probability function, Estimation of means variance, standard deviation.

(9 Hours)

Unit 3 Actual cycles of Engine operation-Their analysis, Use of combustion charts, simulation of engine processes like, suction, compression, evaporation and exhaust. Basic engine operating cycles their analysis and simulation Development of computer programs for these.

(9 Hours)

Unit 4 Modeling : Modeling of Carburetion and injection process and simulation of these process,development of simple programs for analysis. Results of simulation, simulation of engine trouble shooting.

(9 Hours)

Unit 5 Fuels and Combustion : Characteristics –Classification-Handling and Storage -Flash and Fire Points.-Calorific Value Determination of CV by Bomb Calorimeter-Proximate and Ultimate Analysis Solid Fuels, Liquid ,Fuels, Gaseous.

(9 Hours)

Reference Books:

1. Simulation modeling and analysis – Averill M. Law, WD Kelton , TMH.
2. System Simulation – Geoffrey Gordon, Prentice Hall
3. Discrete System simulation – Jerry Banks, John S. Carson, PHI.