Prof. Ram Meghe Institute Of Technology And Research

Badnera –Amravati

An Autonomous Institute Affiliated to Sant Gadge Baba Amravati University, Amravati, Maharashtra (India)

PROGRAMME SCHEME & SYLLABI

2024-25

M.Tech.

(Thermal Engineering)

Prof. Ram Meghe Institute Of Technology And Research, Badnera - Amravati.

Published By

Principal

Prof. Ram Meghe Institute Of Technology And Research, Badnera - Amravati.

Prof. Ram Meghe Institute of Technology and Research, Badnera-Amravati (An Autonomous Institute)
Two Year Post Graduate Degree Program in Master of Technology
Choice Based Credit System (Semester Pattern)
Branch : Mechanical Engineering (Thermal Engineering)

SEMESTER: I																			
Sr. No.	Subject Code	Subject	Teaching Scheme					Examination Scheme											
			Hours/ Week			Total Hours/ Week	Credits	THEORY							PRACTICAL				
			Lecture	Tutorial	P/D			Duration of paper (Hrs)	Max. Marks ESE/ ESSE	Internal Marks		Total	Min. Passing Marks in ESE/ ESSE	Overall Min Passing Marks	Max. Marks		Total	Min. Passing Marks
										Max. Marks MSE/ MSIE	Max. Marks TA				Int.	Ext.		
Theory																			
01	1SMTTE1	Advanced Thermodynamics	3	--	--	3	3	3	60	30	10	100	24	50	--	--	--	--	
02	1SMTTE2	Fluid Dynamics	3	--	--	3	3	3	60	30	10	100	24	50	--	--	--	--	
03	1SMTTE3	Advanced Heat Transfer	3	--	--	3	3	3	60	30	10	100	24	50	--	--	--	--	
04	1SMTTE4	Professional Elective-I	3	--	--	3	3	3	60	30	10	100	24	50	--	--	--	--	
05	1SMTTE5	Professional Elective-II	3	--	--	3	3	3	60	30	10	100	24	50	--	--	--	--	
06	1SMTTE6	Research Methodology & IPR	2	--	--	2	2	3	60	30	10	100	24	50	--	--	--	--	
Practicals																			
07	1SMTTE7	Fluid Dynamics Laboratory			2	2	1	..	..		..	..	..		25	25	50	25	
08	1SMTTE8	Advanced Heat Transfer Laboratory			2	2	1	..	..		..	..	..		25	25	50	25	
09	1SMTTE9	Thermal Engineering - Lab			2	2	1	..	..		..	..	..		25	25	50	25	
		Total	**17**		**6**	**23**	**20**	**..**	**..**		..	**600**	..	..	..		150		
															Total	**750**			

Professional Elective I		1SMTTE4PE1A: Energy Conservation and power plant Economics 1SMTTE4PE1B: Modern Energy Sources 1SMTTE4PE1C: Environmental Pollution Control
Professional Elective II		1SMTTE5PE2A: Advanced Mathematics 1SMTTE5PE2B: Engineering Experimental Techniques 1SMTTE5PE2C: Optimization Techniques

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Two Year Post Graduate Degree Program in Master of Technology

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Branch : Mechanical Engineering (Thermal Engineering)

SEMESTER: II

Sr. No.	Subject Code	Subject	Teaching Scheme					Examination Scheme										
			Hours/ Week			Total Hours/ Week	Credits	THEORY							PRACTICAL			
			Lecture	Tutorial	P/D			Duration of paper (Hrs)	Max. Marks ESE/ ESSE	Internal Marks		Total	Min. Passing Marks in ESE/ ESSE	Overall Min Passing Marks	Max. Marks		Total	Min. Passing Marks
										Max. Marks MSE/ MSIE	Max. Marks TA				Int.	Ext.		
Theory																		
01	2SMTTE1	Advanced Internal Combustion Engines	3	--	--	3	3	3	60	30	10	100	24	50				
02	2SMTTE2	Advanced Refrigeration Engineering	3	--	--	3	3	3	60	30	10	100	24	50				
03	2SMTTE3	Solar Energy	3	--	--	3	3	3	60	30	10	100	24	50				
04	2SMTTE4	Professional Elective-III	3	--	--	3	3	3	60	30	10	100	24	50				
05	2SMTTE5	Professional Elective-IV	3	--	--	3	3	3	60	30	10	100	24	50				
Practicals																		
06	2SMTTE6	Advanced Internal Combustion Engines - Lab			2	2	1								25	25	50	25
07	2SMTTE7	Advanced Refrigeration Engineering - Lab			2	2	1								25	25	50	25
08	2SMTTE8	Solar Energy - Lab			2	2	1								25	25	50	25
09	2SMTTE9	Mini-Project & Seminar -1			4	4	2	--	--	--	--	--	--	--	50	50	100	50
		Total	**15**		**10**	**25**	**20**					**500**					250	
															Total	**750**		

Mini-Project & Seminar -1 : Project shhould be relevant to current technology and must include innovative element, Seminar1: It will be based on Mini-Project

Professional Elective III	2SMTTE4PE3A: Heat Exchanger Design 2SMTTE4PE3B: Advanced Air Conditioning System 2SMTTE4PE3C: Gas Turbine and Jet Propulsion
Professional Elective IV	2SMTTE5PE4A: Fuels and Combustion 2SMTTE5PE4B: Cryogenics 2SMTTE5PE4C: CFD

Exit Option after completion of First Year: Student has to complete 10 credit online courses (NPTEL/MOOCS/SWAYAM) suitable for Thermal Engineering to qualify for the **Post-Graduate Diploma in Thermal Engineering**

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SEMESTER: III																		
Sr. No.	**Subject Code**	**Subject**	**Teaching Scheme**					**Examination Scheme**										
			HOURS/WEEK			**Total HOURS/WEEK**	**CREDITS**	**THEORY**						**PRACTICAL**				
			LECTURE	**TUTORIAL**	**P/D**			**Duration of paper (Hrs)**	**Max. Marks Theory Paper**	**Internal Marks**		**Total**	**Min. Passing Marks**	**Max. Marks**		**Total**	**Min. Passing Marks**
										Unit Test	**Term Work**			**Int.**	**Ext.**		
Practicals																		
01	3SMTTE1	Compulsary Internship Two months (After complition of 1st year)	--	--	--	--	6	--	--	--	--	--	--	--	200	200	100	
02	3SMTTE2	Seminar & Dissertation Phase -I	--	--	8	8	4	--	--	--	--	--	--	100	--	100	50	
		Total			**8**	**8**	**10**										--	
															Total	**300**		

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SEMESTER: IV																			
Sr. No.	**Subject Code**	**Subject**	**Teaching Scheme**					**Examination Scheme**											
			Hours/ Week			**Total Hours/ Week**	**Credits**	**THEORY**							**PRACTICAL**				
			Lecture	**Tutorial**	**P/D**			**Duration of paper (Hrs)**	**Max. Marks ESE/ ESSE**	**Internal Marks**		**Total**	**Min. Passing Marks in ESE/ ESSE**	**Overall Min Passing Marks**	**Max. Marks**		**Total**	**Min. Passing Marks**
										Max. Marks MSE/ MSIE	**Max. Marks TA**				**Int.**	**Ext.**		
Practicals																		
01	4SMTTE	Seminar & Dissertation Phase -II	--	--	20	20	10	--	--	--	--	--	--	--	100	200	300	150
		Total			20	20	10									..	**300**	..
																Total	**300**	

Summary of Marks & Credits					
Year	Semester	Sem Marks	Yearly Marks	Sem Credits	Yearly Credits
First Year	I	750	1500	20	40
	II	750		20	
Second Year	III	300	600	10	20
	IV	300		10	
Total		**2100**		**60**	

M.Tech. First Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
1SMTTE1	**Advanced Thermodynamics**	03	00	00	03

Pre-requisites:

1. An introductory background of engineering thermodynamic is needed.
2. An introductory background of physics is needed.
3. An introductory background of chemistry is needed.

Course Learning Objectives:

1: To impart knowledge on apply thermodynamic principles to complex systems.

2: Understand and utilize thermodynamic cycles and processes.

3: To elaborate and explore advanced topics in thermodynamics.

Course Outcomes:

At the end of course, Learner will be able to

1. Apply the laws of thermodynamics to closed and open systems including thermodynamic cycles.
2. Discuss a range of approaches to estimate fluid phase equilibria in one and two component system.
3. Estimate the physical properties of mixtures, especially non-ideal mixtures.
4. Predict the equilibrium of chemical reactions.
5. Understand the governing equations for compressible fluid flows and normal shocks.
6. Analyze the gas power cycles and cogeneration systems.

	Subject: Advanced Thermodynamics	**L**
UNIT I	Review of basic thermodynamic principles, entropy, availability and irreversibility, first and second law analysis of steady and unsteady systems.	6
UNIT II	General thermodynamic relations, fundamentals of partial derivatives, relations for specific heat, internal energy enthalpy and entropy, Joule Thompson co-efficient, Clapeyron equation.	6

UNIT III	Multi component system, review of equation of state for ideal and real gases, thermodynamic surfaces, gaseous mixtures, fugacity, ideal solutions, dilute solutions, activity, non ideal liquid solution, Multi component phase equilibrium, criteria of equilibrium, stability, and heterogeneous equilibrium, binary vapour liquid systems, the nucleus of condensation and the behavior of steam with formation of large and small drops, Gibbs phase rule, higher order phase transition.	6
UNIT IV	Thermodynamics of chemical reaction (combustion); internal energy and enthalpy - first law analysis and second law analysis; basic relations involving partial pressures.	6
UNIT V	Third law of thermodynamics; chemical equilibrium and chemical potential equilibrium constants; thermodynamics of low temperature.	6
UNIT VI	Thermodynamic Optimization: Exergy analysis of Vapor and Gas Power Cycles, Guideline for improving Thermodynamic Effectiveness; Exergy analysis of Simple Power Plant (Steam Plant).	6
	Total	36

Text Books:

1. Engineering Thermodynamics, P.K.Nag, Tata Mc-Graw Hill Publication.
2. Engineering Thermodynamics with applications, M. David Burhardt,Harper and Row Publishers.
3. Engineering Thermodynamics, William L. Haberman and James E.A.John, Allyn and Bacon Publisher.
4. Fundamentals of Classical Thermodynamics, Gordan J Van Wylen,RichardE.Sonntag, Claus Borgnakke , Wiley Publihers.

Reference Books:

1. Thermodynamics: An Engineering Approach, Yunus A. Cengel& Michael A. Boles, Sixth Edition
2. Advanced Engineering Thermodynamics, Adrian Bejan, Wiley-Interscience Publication, Second Edition.
3. Fundamentals of Engineering Thermodynamics, Michael Moran & Howard Shapiro, Wiley & Sons, Sixth Edition.

M.Tech. First Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
1SMTTE2	**Fluid Dynamics**	03	00	00	03

Pre-requisites:

1. Basic knowledge of fluid properties.

Course Learning Objectives:

1. To learn the fluid flow concept & its effect on various bodies.
2. To learn the Simple transformation and inverse transformations of fluid
3. To learn the concept of Boundary layer for turbulent flow & laminar flow.
4. To learn the compressive fluid its properties & its applications.

Course Outcomes:

At the end of course, Learner will be able to understand

1. Demonstrate basic concepts of Fluid flow
2. Apply acquired knowledge basic function of flow on various bodies.
3. Understand the simple transformation and inverse transformations of fluid
4. Understand the concept of Boundary layer for laminar flow
5. Apply the concept of turbulent flow
6. Apply the concept of compressible flow.

	Subject: Fluid Dynamics	**L**
UNIT I	**Fluid flow concepts**: Euler's equations of motion, Navier stoke equation, equation of continuity, Rotational irrotational flows, potential and stream functions, and flow nets circulations.	6
UNIT II	**Basic Function:** Uniform stream, sink, vortex, doublet, superposition of functions, flow over half bodies, Rankine bodies, circular cylinder, Magnus effect.	6

UNIT III	**Conformal Mapping:** Simple transformation and inverse transformations.	6
UNIT IV	**Boundary layer theory:** Boundary layer theory for laminar and Turbulent flow, Blasius solution for flat plate, approximate methods, boundary layer separation and control, Effect of roughness.	6
UNIT V	**Turbulent flow:** Semi empirical theories of turbulence, eddy viscosity, Prandtl's mixing length theory, Karman's Similarity hypothesis, Taylor's Vorticity transfer theory.	6
UNIT VI	**Compressible Flow:** Review of one dimensional compressible flow, approximation to two and three dimensional such as sonic, supersonic flows, small perturbation theory, Shock Waves, Prandtl Mayor's Equation.	6
	Total	36

Text Books :

1. Foundations of Fluid Mechanics, Yuan, S.W., Prentice Hall.
2. Cengel, Y.A. and J.M. Cimbala, Fluid Mechanics, McGraw-Hill,Boston, MA.
3. Mechanics of Fluids, Shames, McGraw-Hill.

Reference Books :

1. Boundary Layer Theory, Schlichting, H., McGraw-Hill,.
2. Fluid Mechanics, Kundu, P. K., and Ira M. Cohen, 4th ed., Academic Press.
3. The Dynamics and Thermodynamics of Compressible Flow, Shappiro, Ronald Press.

M.Tech. First Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
1SMTTE3	**Advance Heat Transfer**	03	00	00	03

Pre-requisites:

1. An introductory background of Maths(calculus) is needed.
2. An introductory background of Physics is needed.
3. An introductory knowledge of heat transfer is needed.

Course Learning Objectives:

1. To provide details of heat transfer involving conduction, convention and radiation mechanisms. Apply appropriate governing equation and boundary conditions to solve lD,2D steady and unsteady state conduction problems.
2. To identify the non-dimensional parameters and their significance in the forced and free convection. Employ proper analogy and empirical correlations for solving convection problems.
3. To describe phenomenon and mechanisms in condensation, boiling, transpiration cooling and ablation heat transfer. Interpret the physical mechanism in heat pipes. To analyze the role of gases as participants in exchange process.

Course Outcomes:

At the end of course, Learner will be able to

1. Solve lD and 2D steady and unsteady state heat conduction problems by utilizing analytical, graphical, numerical and chart solution.
2. Evaluate the performance offins having non-uniform cross section.
3. Use of non-dimensional parameters and empirical correlations to analyse convection heat transfer in external and internal, forced and free convection.
4. Determine heat transfer coefficient in condensation and boiling phenomena and illustrate the physical mechanism involved in heat pipes.
5. Estimate the radiative heat exchange between surfaces.

	Subject: Advance Heat Transfer	**L**
UNIT I	**Steady state conduction:** Basics of heat transfer, General heat conduction equationin rectangular, cylindrical and spherical co-ordinate systems, One dimensional steady state conduction with and without heat generation,	6

UNIT II	Variable thermal conductivity, Critical radius of insulation. Fins of non-uniform cross section. Two dimensional heat conduction, analyical, and graphical methods, Conduction shape factor. lntroduction to finite difference numerical solution.	6
UNIT III	**Unsteady state heat conduction:** Lumped capacitance, Infinite plate of finite thickness, Semiinfinite solid, Applicability of Heisler and Crober charts, Transient numerical methods.	6
UNIT IV	**Convection heat transfer:** Forced convection, Conservation equations, Integral and analyical solutions, Boundary layer analogies, Internal and external flows, Laminar and turbulent flows, Flow across cylinders and tube banks, Empirical solutions. Free convection: Governing equations, Laminar and turbulent flows, Analytical and empirical solutions.	6
UNIT V	**Boiling, Condensation and Heat pipes:** Pool boiling and convective boiling. Film condensation and drop-wise condensation. Transpiration cooling, Ablation. Classification, construction and applications of heat pipe.	6
UNIT VI	**Radiation:** Fundamentals, Radiation shape factor, Heat exchange between non-black bodies using network approach, Enclosure analysis. Radiation shields, gas radiation, radiation network for an absorbing and transmitting medium, Effect of radiation on temperature measurement.	6
	Total	36

Text Books :

1. Heat Transfer by J.P. Holman, Tata McGraw Hill Publication, 9th ed. 2002.
2. Heat Transfer by S.P. Sukhatme, Tata McGraw Hill Publication, 1994

Reference Books :

1. Heat Transfer by P.K. Nag, Tata McGraw Hill Publication, 2005.
2. Heat and Mass Transfer Data Book Book by C P Kothandaraman, S Subramanyam, New Age International,1994
3. Heat Transfer data book Convective heat & mass transfer by Kays and Crawford, Tata
4. C. P. Kothandaraman and S.subramanyam, ,,Heat and Mass Transfer Data Book", Nerv Age International-2014
5. R.C. Sachdeva "Fundamentals of Engineering Heat and Mass Transfer,,, New Age International, 2017.

M.Tech. First Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
1SMTTE4PE1A	**Energy Conservation and power plant Economics**	03	00	00	03

Pre-requisites:

1. Knowledge of Energy Conservation.

Course Learning Objectives:

1. To study various types of Energy Sources.
2. To study energy audit of various systems
3. To study Economic analysis of power plants and targets.
4. To understand Performance and operating characteristics of power plants

Course Outcomes:

At the end of course, Learner will be able to

1. Understand the importance of Energy Sources.
2. Understand the auditing of various systems.
3. Understand the Economic analysis of power plants and targets
4. Understand the working principles of power plants.
5. Understand the Performance characteristics of power plants
6. Understand operating characteristics of power plants

	Subject: Energy Conservation and power plant Economics	**L**
UNIT I	**Energy Conservation :** Energy Sources – Review of Present Status of Conventional and Renewable Energy Sources, Common areas of inefficiency in energy use, principles of energy conservation , energy conservation planning, energy conservation in industries, household, commercial, transport and agricultural fields, energy conservation technologies, energy conservation legislation.	**6**

UNIT II	**Energy Audit:** Energy flow diagram, comparison with standards, energy management team, energy audit of illumination systems and electrical systems, energy audit of various compressed air systems, buildings, steam generation and distribution systems.	**6**
UNIT III	**Demand Side Management:** Scope of Demand Side Management, load management as a Demand Side Management strategy, tariff options of Demand Side Management, Demand Side Management and environment, different types as a captive power plants, energy banking and wheeling, role of private sector in energy management.	**6**
UNIT IV	**Power Plant Economics:** Economic analysis of power plants and targets, Load curves, load duration curve, different terms and definitions; Effect of fluctuating load on operation and design of the plant, methods of meeting fluctuating load, cost of electrical energy; operating costs, generation costs, depreciation cost. Cost benefit analysis, Selection of type of generation;	**6**
UNIT V	**Performance and operating characteristics of power plants;** Selection of the generating equipments, Combined operation of power plants; load division between stations, effect of load factor on energy cost, different types of tariffs.	**6**
UNIT VI	**Environmental Aspects of Energy Generation :** Well-to-Wheel Emission analysis of Energy Sources, Social and economical issues of the power plants, Greenhouse effect, Acid precipitation- acid rain and acid snow, drydeposition and acid fog. Thermal pollution, air pollution, Radiation from nuclear power plant effluents, clean coal technologies, hydro power plants, environmental clearances.	**6**
	Total	**36**

TEXT BOOKS :

1. Power Station Engineering and Economics , B G A Skrotzki , W A Vopat : Tata McGraw Hill Publishing Company Limited, New Delhi,1972.

2. Power Plant Engineering, P K Nag, Tata McGraw Hill Publishing Company Limited, New Delhi ,2006.

REFERENCE BOOKS :

1. Electrical Power Distribution , A S Pabla , Tata McGraw Hill Publishing Company Limited, New Delhi ,2004.

2. Generation of Electrical Energy , B R Gupta, Eurasia Publishing House Private Limited, New Delhi, 2007.

3. Patterns of Energy Use in Developing Countries, Ashok V Desai,al issues of the power plants, Greenhouse effect, Acid precipitation- acid rain and acid snow, dry

M.Tech. First Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
1SMTTE4PE1B	**Modern Energy Sources**	03	00	00	03

Pre-requisites:

Knowledge of Non conventional energy sources

Course Learning Objectives:

1. To study various types of collectors.
2. To study various Tidal and Ocean Energy.
3. To study Wind Energy.
4. To understand Geothermal Energy And Magneto Hydrodynamics

Course Outcomes:

At the end of course, Learner will be able to

1. Understand the importance and principles of collectors.
2. Understand the working & utilization of Tidal and Ocean Energy
3. Understand the working principles of Wind Energy.
4. Understand Magneto Hydrodynamics.
5. Understand Nuclear Energy.

	Subject: Modern Energy Sources	**L**
UNIT I	**Solar Energy**: Flat plate and concentrating collectors- design, analysis and performance, applications. Thermal Power, Photovoltaic power; Economic Analysis.	6
UNIT II	**Solar Thermal Energy Storage:** Types: Sensible storage; Latent heat storage; Thermo-chemical storage. Design of storage System. Solar Thermal Energy system: Solar still; Solar cooker: Solar pond; Solar passive heating and cooling systems: Trombe wall; Greenhouse technology: Fundamentals, design, modeling and applications.	6
UNIT III	**Tidal and Ocean Energy:** Applications, Design aspects, Power generation methods, various cycles and analysis.	6

UNIT IV	**Wind Energy:** Atmospheric circulation, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS: classification, Characteristics, application, design aspects.	6
UNIT V	**Geothermal Energy And Magneto Hydrodynamics:** Study of various Components, Performance and methods of energy conversion.	6
UNIT VI	**Nuclear Energy:** Fusion and fission, study of various components, Design aspects, performance and methods of power generation.	6
	Total	36

TEXT BOOKS :

1. Power Plant Technology by El- Wakil, McGraw Hill publication.
2. Solar Energy : Fundamentals and Applications (1st Revised Edition), Tata McGraw-Hill,

REFERENCES :

1. Solar Energy: Principles of thermal collection and Storage by Suhas P. Sukhatme ,Second Edition, Tata McGraw-Hill, 2006
2. Principles of Solar Thermal Engineering by F.Kreith & J .F.Kreider, McGraw Hill Publications 1978.
3. Solar Engineeering of thermal Processes by J .A.Duffie and W.A.Beckman, John Wiley & Sons publication 1999.
4. Applied Solar Energy by A.B.Meinal & F.P.Meinal, Addison Wesley

M.Tech. First Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
1SMTTE4PE1C	**Environmental Pollution Control**	03	00	00	03

Pre-requisites: Nil

Course Learning Objectives:

1. To impart knowledge on the atmosphere and its present condition, global warming and eco legislations.
2. To detail on the sources of air, water and noise pollution and possible solutions for mitigating their degradation.
3. To elaborate on the technologies available for generating energy from waste.

Course Outcomes:

At the end of course, Learner will be able to

1. Understand the Foundations of Environmental Pollution Control
2. Analyze and Mitigate Air Pollution
3. Evaluate Water Pollution and Remediation Techniques
4. Implement Sustainable Waste Management Practices
5. Manage Diverse Industrial Pollution Sources
6. Integrate Pollution Control Strategies Holistically

	Subject: Environmental Pollution Control	**L**
UNIT I	**INTRODUCTION:** Global atmospheric change – green house effect – Ozone depletion - natural cycles - mass and energy transfer – material balance – environmental chemistry and biology – impacts – environmental. Legislations.	6
UNIT II	**AIR POLLUTION:** Pollutants - sources and effect – air pollution meteorology – atmospheric dispersion – indoor air quality - control methods and equipments - issues in air pollution control – air sampling and measurement.	6
UNIT III	WATER POLLUTION: Water resources - water pollutants - characteristics – quality - water treatment systems – waste water treatment - treatment, utilization and disposal of sludge - monitoring compliance with standards.	6
UNIT IV	WASTE MANAGEMENT: Sources and Classification – Solid waste – Hazardous waste - Characteristics – Collection and Transportation - Disposal – Processing and Energy Recovery – Waste minimization.	6

UNIT V	OTHER TYPES OF POLLUTION FROM INDUSTRIES: Noise pollution and its impact - oil pollution - pesticides - instrumentation for pollution control .	6
UNIT VI	Water pollution from tanneries and other industries and their control – environment impact assessment for various projects – case studies. Radiation pollution: types, sources, effects, control of radiation pollution.	6
	Total	36

REFERENCE BOOKS

1. Arcadio P Sincero and G.A. Sincero, Environmental Engineering – A Design Apporach, Prentice Hall of India Pvt Ltd, New Delhi.
2. Bishop P., Pollution Prevention: Fundamentals and Practice, McGraw-Hill International Edition, McGraw-Hill book Co, Singapore.
3. G.Masters, Introduction to Environmental Engineering and Science Prentice Hall of India Pvt Ltd, New Delhi.
4. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2nd Edition, Prentice Hall, 1998.
5. H.Ludwig, W.Evans, Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands N.J. (1991).
6. H.S.Peavy, D.R.Rowe and G.Tchobanoglous, Environmental Engineering McGraw- Hill Book Company, NewYork, (1985).
7. Rao C.S., Environmental Pollution Control Engineering, 2nd Edition, New Age International Publishers, 2006.

M.Tech. First Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
1SMTTE5PE2A	**Advanced Mathematics**	03	00	00	03

Pre-requisites:

1. Elementary knowledge of differential and integral calculus.
2. Fundamental knowledge of partial differentiation.
3. Basic idea of probability.

Course Learning Objectives:

1: To investigate the solutions of certain type of differential equations and boundary value Problems.

2: To express given data connecting two variables in equation form.

3: To understand the concept of differences of a function.

4: To solve differential equations by different methods.

Course Outcomes:
At the end of course, Learner will be able to

1. Find the solution of linear partial differential equation with boundary conditions.
2. Apply empirical laws to the given data by graphical method connecting two variables.
3. Evaluate the functions for intermediate values by interpolation.
4. Solve differential equation by various methods.

	Subject: Advanced Mathematics	**L**
UNIT I	**Partial Differential Equations:** Linear partial differential equations with constant coefficients and its solution, complimentary function and particular integral.	6
UNIT II	**Ordinary Differential Equations:** Runge - Kutta methods for system of IVPs – Numerical stability of Runge - Kutta method – Adams - Bashforth multistep method, Shooting method, BVP : Finite difference method, Collocation method and orthogonal collocation method.	6
UNIT III	**Applications of Partial Differential Equations:** Method of separation of variables, solution of wave equation, one dimensional and two dimensional heat flow equation in steady state (Laplace Equation) and its solution.	6

UNIT IV	**Statistics:** Method of least squares, curve fitting by graphical method. Co-relation regression. Probability: Binomial distribution, Poisson's distribution and Normal distribution.	6
UNIT V	**Interpolation:** Newton's interpolation formulae, Newton's and Gauss's forward and backward interpolation formulae, Interpolation with unequal intervals, Lagrange's formula for unequal intervals. Newton's divided difference formula. Inverse interpolation.	6
UNIT VI	**Numerical Methods:** Numerical integration, Trapezoidal rule, Simpson's one third and three eighth rule, Weddle's rule. Numerical solution of ordinary differential equations by Taylor's series method, Runge-Kutta's fourth order method, Euler's method.	6
	Total	36

Text Books:

1. Advance Engineering Mathematics by Erwin Kreyszig, 7^{th} and 8^{th} Edition. Wiley Eastern.
2. Higher Engineering Mathematics by B. S. Grewal.

Reference Books:

1. Fundamentals of Statistics by S. C. Gupta.

M.Tech. First Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
1SMTTE5PE2B	**Engineering Experimental Techniques**	03	00	00	03

Pre-requisites:

1. Students should have knowledge of various experiments in engineering.

Course Learning Objectives:

1. To study principles of generalized measurement system
2. To study the basic of intermediate instrumentation
3. To study the dynamic response system.
4. To study the Experimental planning

Course Outcomes:

At the end of course, Learner will be able to

1. Understand the principles of generalized measurement system
2. Understand the basic intermediate instrumentation
3. Understand the dynamic response system.
4. Understand the Experimental planning

	Subject: Engineering Experimental Techniques	**L**
UNIT I	Generalized measuring systems, different transducers for measurement of different mechanical parameters such as thickness (length), temperature, pressure, force, torque, etc., their design consideration, characteristics, limitation and uses.	8
UNIT II	Intermediate stage instrumentation, Impedance matching, selection of intermediate instrumentation equipments	6
UNIT III	Terminating stage devices- characteristics, limitations	6
UNIT IV	Dynamic response of instruments, Effect of different instruments used in the measuring system on the accuracy, sensitivity and performance of the instrument designed to measure a particular mechanical parameter.	6

UNIT V	Experimental planning, parliamentary, intermediate and final stages, a experimental investigations	6
UNIT VI	selection of instruments based on static, dynamic characteristics and allowable errors, analysis of experimental data, curve fitting, report writing	6
	Total	38

REFERENCE BOOKS :

1) Experimental methods for engineering by J.P. Holman

2) Measurement System, Application and Design by E.D. Doeblein

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Course Code	Course Title	L	T	P	C
1SMTTE5PE2C	**Optimization Techniques**	03	00	00	03

Pre-requisites:

1. Students should have knowledge of optimization s in engineering.

Course Learning Objectives:

1. To study various types of Classical Optimization Techniques
2. To study the Constrained Optimization Techniques
3. To study the Genetic Algorithm
4. To study the Theory of Constraints

Course Outcomes:

At the end of course, Learner will be able to

1. Understand the various types of Classical Optimization Techniques
2. Understand the Constrained Optimization Techniques
3. Understand the Genetic Algorithm
4. Understand the Theory of Constraints

	Optimization Techniques	**L**
UNIT I	Classical Optimization Techniques: Single-variable and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers Method, Kuhn-Tucker Condition	7
UNIT II	Single-variable Optimization Techniques: Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval-halving Method, Fibonacci Method, Golden-section Method, Quadratic Interpolation Method, Newton Method, Quasi-Newton Method, Secant Method	6
UNIT III	Multi-variable Optimization Techniques: Evolutionary Optimization Method, Simplex Search Method, Pattern Search Method, Conjugate Direction Method, Steepest Descent Method, Newton's Method, Conjugate Gradient Method, Davidon-Fletcher-Powell Method	6
UNIT IV	Constrained Optimization Techniques: Interior Penalty Function Method, Exterior Penalty function Method.	6
UNIT V	Genetic Algorithm, Simulated Annealing, Artificial Neural Networks	6
UNIT VI	Theory of Constraints: Introduction to TOC, Optimized Production Technology (OPT), Nine principles of OPT, Five Focusing Steps (The 5FS) of TOC, Capacity Constrained Resources and the Time Buffer, Modeling the Time Buffer, Modeling Return-On-Investment (ROI) in TOC, Comparison of TOC and Local Optimization Approaches	7
	Total	38

REFERENCE BOOKS:

1. Deb K (2004). Optimization for Engineering Design: Algorithms and Examples, Prentice Hall of India.
2. Dennis J Jr, Schnabel R (1996). Numerical Methods for Unconstrained Optimization and Nonlinear Equations, Society for Industrial and Applied Mathematics.
3. Rao S (1996). Engineering optimization, Theory and Practice, New Age International Publishers
4. Ravindran A, Ragsdell K and Reklaitis G (2006). Engineering Optimization: Methods and Applications, 2nd edition, John Wiley and Sons Inc.
5. Goldratt, E. M. and Cox, J. (2004). The Goal: A Process of Ongoing Improvement. 3rd Edition, North River Press. ISBN-10: 0884271781, ISBN-13: 978-0884271789
6. Dettmer, H. William (1997). Goldratt's Theory of Constraints: A Systems Approach to Continuous Improvement, American Society for Quality. ISBN 0873893700, 9780873893701.

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Course Code	Course Title	L	T	P	C
1SMTTE6	**Research Methodology & IPR**	02	00	00	02

Course Learning Objectives:

1. To understand the role of research methodology, literature review process and formulation of a research problem
2. To understand data collection methods and statistical tools for data analysis
3. To learn technical writing skills required for research
4. To create awareness about intellectual property rights and research ethics

Course Outcomes: At the end of course, Learner will be able to

1. Understand the role of research methodology in Engineering
2. Understand literature review process and formulation of a research problem
3. Understand data collection methods and basic instrumentation
4. Learn various statistical tools for data analysis
5. Learn technical writing skills required for research
6. Create awareness about intellectual property rights and patents

	Subject: Optimization Techniques	**L**
UNIT I	Definition of research, Characteristics of research, Types of research- Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, Overview of research methodology in various areas, Introduction to problem solving, basic research terminology such as proof, hypothesis etc.	4
UNIT II	Literature review, sources of literature, various referencing procedures, Identifying the research areas from the literature review and research database, Problem Formulation, Identifying variables to be studied, determining the scope, objectives, limitations and or assumptions of the identified research problem, Justify basis for assumption, Formulate time plan for achieving targeted problem solution.	4
UNIT III	Important steps in research methods: Observation and Facts, Laws and Theories, Development of Models, Developing a research plan: Exploration, Description, Diagnosis and Experimentation	4
UNIT IV	Static and dynamic characteristics of instruments, calibration of various instruments, sampling methods, methods of data collection, Basic Concepts concerning testing of hypotheses, procedures of hypothesis testing, generalization and interpretation	4
UNIT V	Introduction: Structure and components of scientific reports, types of report, developing research proposal. Thesis writing: different steps and software tools in the design and preparation of thesis, layout, structure and language of typical reports,	4

	Illustrations and tables, bibliography, referencing and footnotes,	
UNIT VI	IPR and ethics in Research: Intellectual property rights and patent law, techniques of writing a Patent, filing procedure, technology transfer, copy right, royalty, trade related aspects of intellectual property rights Publishing: design of research paper, citation and acknowledgement, plagiarism tools, reproducibility and accountability.	4
	Total	24

Reference Books:

1. Ranjit Kumar, "Research Methodology: A Step by Step Guide for Beginners", SAGE Publications Ltd., 2011.
2. Wayne Goddard, Stuart Melville, "Research Methodology: An Introduction" JUTA and Company Ltd, 2004.
3. C.R. Kothari ,"Research Methodology: Methods and Trends", New Age International,2004
4. S.D. Sharma , "Operational Research", Kedar Nath Ram Nath & Co.,1972
5. B.L. Wadehra,"Law Relating to Patents,Trademarks, Copyright Designs and Geographical Indications", Universal Law Publishing, 2014.
6. Donald Cooper, Pamela Schindler, "Business Research Methods", McGraw-Hill publication, 2005.

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Course Code	Course Title	L	T	P	C
1SMTTE7	**Fluid Dynamics Laboratory**	00	00	02	01

Pre-requisites:

Knowledge of Basic Fluid mechanics & Fluid dyanamics

Course Learning Objectives (CLOs)

1. To learn the fluid properties & behavior using various devices
2. To learn measurement fluid flow using pumps & turbines

Course Outcome (COs)

1. Demonstrate the fluid pressure measurement
2. Apply the Bernoulli's equation
3. Apply & analyze fluid flow using pumps & turbines

Practical's: At least 5 practical's from the below list.

1 Analyze the fluid pressure measurement by various measuring devices.

2. Verification of Bernoulli's equation.

3. Determination of co-efficient discharge by Venturimeter.

4. Calculation of Reynolds number for Laminar & Turbulent flow.

5. Trial/Study of hydraulic Turbines.

6. Study & analysis of fluid flow using centrifugal & reciprocating pump.

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Course Code	Course Title	L	T	P	C
1SMTTE8	**Advanced Heat Transfer Laboratory**	00	00	02	01

Pre-requisites: Basic Knowledge of Heat Transfer

Course Learning Objectives (CLOs)

1. To provide details of heat transfer involving conduction, convention and radiation mechanisms.
2. To understand heat transfer analysis and to demonstrate different techniques used in solving a heat transfer problem.
3. To evaluate basics of designing heat transfer equipment.

Course Outcome (COs)

1. Understand various modes of 1D and 2D steady and unsteady state heat transfer.
2. Evaluate various parameters of the radiation mode heat transfer process.
3. Apply the knowledge of different application of heat pipe as heat transfer

Practical's:

1. Analysis of 3-D heat conduction with internal heat generation for a solid cylinder under unsteady state condction.
2. To determine the surface heat transfer coefficient for heated vertical cylinder in natural convection.
3. Study of radiation shape factor, their salient features and application.
4. Analysis of radiation heat exchange between non-black bodies using network analogy.
5. To determine the heat transfer coefficient in film wise and drop wise condensation.
6. Study of heat pipes.
7. To study the super thermal conducting characteristics of heat pipe.

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Course Code	Course Title	L	T	P	C
1SMTTE9	**Thermal Engineering - Lab**	00	00	02	01

Pre-requisites:

Basic knowledge of Thermodynamics & power plant

Course Learning Objectives (CLOs)

1. To impart knowledge on apply thermodynamic principles to complex systems.
2. To Understand and utilize thermodynamic cycles and processes.
3. To elaborate and explore advanced topics in thermodynamics.

Course Outcome (COs)

1. Analysis the performance test on steam power cycles in thermal power plant.
2. Resolve the problems involving steam nozzles and steam turbines.
3. Estimate the various properties of lubrication oils.
4. Recognize the components and conduct the performance test on internal combustion engines.

Practical's:

1. To study of analysis of the thermal power plant.
2. To Study and demonstration of Steam Generators and Turbines
3. Analysis of Retardation Test to find Frictional Power of a Diesel Engine.
4. Analysis and determination of Flash Point and Fire Point of various fuels / lubricants.
5. Analysis and determination of Viscosity – using Red Wood Viscometer.
6. To study the chilling plant and its working cycle.
7. To study of analysis of Cascade Refrigeration System for Low Temperature Application.

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Course ode	Course Title	L	T	P	C
2SMTTE1	**Advanced Internal Combustion Engines**	03	00	00	03

Pre-requisites:

1. An introductory background of thermodynamics is needed.
2. An introductory background of IC Engines is needed.
3. An introductory background of chemistry is needed.

Course Learning Objectives:

1. To understand the underlying principles of operation of different IC Engines and components.
2. To provide knowledge on pollutant formation, control, alternate fuel etc.
3. To provide knowledge on alternative fuels and Recent trends

Course Outcomes:

At the end of course, Learner will be able to

1. Understand the fundamentals of combustion, thermodynamics of combustion, different combustion processes,
2. Apply knowledge to solve simple/advance numerical problem of a combustion system
3. Ability to analyze and design a combustion system such as furnace and burner
4. An understanding of pollutant formation in internal combustion engines
5. An understanding of the fundamental theory of the combustion of non-premixed and premixed flames, laminar and turbulent flames, droplets and the theory of ignition

	Subject: Advanced Internal Combustion Engines	L
Unit-1	SPARK IGNITION ENGINES: Spark ignition engine mixture requirements – Fuel – Injection systems – Monopoint, Multipoint injection, Direct injection – Stages of combustion – Normal and abnormal combustion – Factors affecting knock – Combustion chambers.	6
Unit-2	COMPRESSION IGNITION ENGINES: States of combustion in C.I. Engine – Direct and indirect injection systems – Combustion chambers – Fuel spray behaviour – Spray structure, Spray penetration and evaporation – Air motion – Introduction to Turbo charging.	6
Unit-3	POLLUTANT FORMATION: Pollutant – Sources – Formation of carbon monoxide, Unburnt hydrocarbon, NOx, Smoke and Particulate matter	6
Unit-4	POLLUTANT CONTROL: Methods of controlling Emissions – Catalytic converters and Particulate Traps – Methods of measurements and Introduction to emission norms and Driving cycles.	6

Unit-5	ALTERNATIVE FUELS: Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications.	6
Unit-6	RECENT TRENDS: Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines – Plasma Ignition – Measurement techniques – Laser Doppler, Anemometry.	6
	Total	36

BOOKS RECOMMENDED:
TEXT BOOK:

1. K.K. Ramalingam, Internal Combustion Engine Fundamentals, Scitech Publications, 2002.

2. R.B.Mathur and R.P. Sharma, Internal combustion Engines.

3. V. Ganesan, Internal Combustion Engines, II Edition, Tata McGraw- Hill, 2002.

REFERENCE BOOKS:

1. Duffy Smith, Auto fuel Systems, The Good Heart Willox Company,Inc.

2. John B. Heywood, Internal Combustion Engine Fundamentals first edition

3. Willard W. Pulkrabek, engineering fundamentals of the Internal Combustion Engine second edition

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Course Code	Course Title	L	T	P	C
2SMTTE2	**ADVANCED REFRIGERATION ENGINEERING**	03	00	00	03

Pre-requisites:

1. An introductory background of thermodynamics is needed.
2. An introductory background of refrigeration is needed.
3. An introductory background of chemistry is needed.

Course Learning Objectives:

1. Analyze and Design Advanced Refrigeration Systems
2. Optimize Refrigeration Processes for Energy Efficiency
3. Apply Refrigerant Component technology

Course Outcomes:

At the end of course, Learner will be able to

1. Analyze the reversed Carnot cycle and vapour compression refrigeration cycle (VCR).
2. Select the air-refrigeration systems for aircraft.
3. Study and analyze vapour absorption refrigeration system for rural and remote areas.
4. Select environmental friendly refrigerants considering the international standards.
5. Select multi pressure systems
6. Study different Non-Conventional Refrigeration systems.

	Subject: ADVANCED REFRIGERATION ENGINEERING	**L**
UNIT I	Review of Basic Refrigeration Cycles: Reverse Carnot Cycle, Second Law of Thermodynamics. Vapor Compression Refrigeration. Standard and Actual Compression Cycle.	6
UNIT II	Multi Pressure Systems: Refrigeration Component Matching and System Integration, Thermodynamics of Va-por Absorption Refrigeration.	6
UNIT III	Non Conventional Refrigeration Systems with elementary analysis.	6

UNIT IV	Properties of Refrigerants: Green House Effect, Numbering and Color Coding of Refrigerants, Recent Trends in Refrigerants.	6
UNIT V	Air as refrigerant and air refrigeration cycles/systems.	6
UNIT VI	Refrigerant Component Matching and Designing Refrigeration Components like Compressor, Condenser, Cap-illary, Condenser, Etc	6
	Total	36

TEXT BOOKS:

1. Refrigeration and air conditioning, Ahmadul Ameen, Prentice Hall of India, New Delhi, 2006

2. Refrigeration and air conditioning, C P Arora, Tata McGraw-Hill, 2nd ed ,2003

REFERENCE BOOKS :

1.Refrigeration and Air Conditioning Technology, Tomczyk, J. A., Whitman, W. C., Johnson, W. M., Pub: Delmar S.Africa, 4th edition, 2000.

2.Electricity For Refrigeration, Heating, and Air Conditioning, Russell E. Smith, Delmar Cengage Learning; 7th edition, 2006 3. The ASHRAE Handbooks with CDs, 2005-2008.

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Course Code	Course Title	L	T	P	C
2SMTTE3	**SOLAR ENERGY**	03	00	00	03

Pre-requisites:

Knowledge of energy conversion & renewable sources

Course Learning Objectives:

CLO1. To study various types of Radiative Properties and Characteristics of Materials.

CLO 2. To study various Solar Thermal Energy Storage

CLO 3. To study various types of Solar Heating & Cooling System.

CLO 4. To understand Performances of solar collectors

Course Outcomes:

At the end of course, Learner will be able to

- Understand the Radiative Properties and Characteristics of Materials.
- Understand the working & applications of Solar Thermal Energy Storage
- Understand the Solar Energy for Industrial Process Heat
- Understand the working principles of Solar Heating & Cooling System.
- Understand the working of solar collectors

	Subject: SOLAR ENERGY	**L**
UNIT I	**Radiative Properties and Characteristics of Materials** Reflection from ideal specular, ideal diffuse and real surfaces, Selective Surfaces: Ideal coating characteristics; Types and applications; Antireflective coating; Preparation and characterization. Reflecting Surfaces and transparent materials.	6
UNIT II	**PHOTOVOLTAIC SOLAR CELL** P:N Junction - Metal - Schottky Junction, Electrolyte – Semiconductor Junction, Types of Solar Cells - their Applications - Experimental Techniques to determine the Characteristics of Solar Cells - Photovoltaic Hybrid Systems Photovoltaic Thermal Systems – Storage Battery - Solar Array and their Characteristics Evaluation - Solar Chargeable Battery.	6
UNIT III	**Solar Energy for Industrial Process Heat** Industrial process heat: Temperature requirements, consumption pattern; Applications of solar flat plate water heater & air heater for industrial process heat;	6

	Designing thermal storage; Transport of energy.	
UNIT IV	**Solar Heating & Cooling System** Solar water heating systems, Liquid based systems for buildings, Solar air heating systems, Methods of modeling and design of Solar heating system, Cooling requirements of buildings, Vapour absorption refrigeration cycle; Water, ammonia & lithium bromide-water absorption refrigeration systems; Solar desiccant cooling.	6
UNIT V	**Performances of solar collectors** ASHRAE code; Modeling of solar thermal system components and simulation; Design and sizing of solar heating systems: f – chart method and utilizability methods of solar thermal system evaluation; Development of computer package for solar heating and cooling applications; Energy balance for Flat Plate Collectors; Thermal analysis; Heat capacity effect; Testing methods; Types of Flat Plate Collectors: Liquid Flat Plate Collectors, Air flat-plate Collectors- Thermal analysis; Evacuated tubular collectors.	6
UNIT VI	**Concentrating Collector Designs** Classification, design and performance parameters; Tracking systems; Compound parabolic concentrators; Parabolic trough concentrators;Concentrators with point focus; Heliostats; Comparison of various designs: Central receiver systems, parabolic trough systems; Solar power plant; Solar furnaces	6
	Total	36

TEXT BOOKS:

1. S.P.Sukhatme-Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill

2. J.A.Duffie and W.A.Beckman-Solar Engineering of Thermal Processes-John Wiley, (1991).

REFERENCE BOOKS:

J.F.Kreider and F.Kreith-Solar Energy Handbook McGraw-Hill (1981).

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Course Code	Course Title	L	T	P	C
2SMTTE4PE3A	**HEAT EXCHANGER DESIGN**	03	00	00	03

Pre-requisites:

1. An introductory background of Maths(calculus) is needed.
2. An introductory background of Physics is needed.
3. Background of Thermodynamic and Heat Transfer are needed.

Course Learning Objectives:

1. It provides exposure to different kind of heat exchanger, their working and selection for a given application. To learn the thermal and stress analysis on various parts of the heat exchangers.
2. To analyze the sizing and rating of the heat exchangers for various applications. Students will come to know about different techniques of heat exchanger analysis.
3. To learn construction and thermal design methodology of shell and tube, Plate and compact heat exchanger.

Course Outcomes:

At the end of course, Learner will be able to

1. Understand the details knowledge for heat exchanger classification & its application.
2. Analyze the design methodology of heat exchanger with reference to rating and sizing.
3. Interpret the knowledge of fouling of heat exchanger & its operational control.
4. Design and Analysis of Shell & tube Heat Exchanger performance.
5. Design and Analysis of compact heat exchanger performance.
6. Analyze an existing heat exchanger for phase change application.

	Subject: HEAT EXCHANGER DESIGN	**L**
UNIT I	**Introduction to Heat Exchangers:** Mechanism of heat exchange, classification, geometrical construction of tubular, plate and compact heat exchanger, extended surface heat exchangers, regenerator's heat pipe, & its Applications and Selection. Classification according to flow arrangement: counter flow, parallel flow, cross flow exchanger & its application.	6
UNIT II	**Basic Design Methods of Heat Exchanger:** Heat exchanger design methodology, problem formulation, e-NTU method, PNTU method, Mean temperature difference method (LMTD) for heat exchanger analysis for parallel, counter, and cross flow heat exchanger. Heat exchanger design calculation- heat transfer and pressure drop calculation including pumping power, Heat exchangers design methodology- rating and sizing.	6

UNIT III	**Fouling of Heat Exchangers:** Basic consideration, effect of fouling on heat transfer and pressure drop, cost of fouling, design of heat exchangers subject to fouling, fouling resistance, cleanliness factor, techniques to control fouling, Process of Fouling, Prediction of fouling, Operation of heat exchanger under fouling, Control of fouling and cleaning of heat exchanger.	6
UNIT IV	**Design Of Shell & Tube and Compact Heat Exchanger:** Basic components, TEMA code, J-factors & other standards, Basic design methodology – heat transfer and pressure drop calculation, Shell side calculation- KERN'S and Bell-Delaware Method. Plate fin and tube fin heat, Helical Coil Heat Exchangers and Air Cooled Heat Exchanger: Application, mechanical features, operational characteristics, flow arrangement, heat transfer and pressure drop calculation	6
UNIT V	**Mechanical Design of Heat Exchangers.:** Design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major components such as tube sheet, shell, tubes, flanges and nozzles. Introduction to simulation and optimization of heat exchangers, flow induced vibrations.	6
UNIT VI	**Heat Exchangers for Phase Change Applications:** Condensers and Evaporators, Features, types, construction, working, design and operational considerations, and its thermal analysis.	6
	Total	36

BOOKS RECOMMENDED:

Text Books:

1. Fundamentals of Heat Exchanger Design by Ramesh K. Shah, Dusan P Sekulic, 1st edition, Wiley, 2002. 60 61
2. Process Heat Transfer by D.Q. Kern, Tata McGraw Hill Publication, 1999.
3. Mechanical design of heat exchanger design & Pressure vessel component, by Sing K.P. A. I.; Arcturus Publishers Cherry Hill, 2006.
4. Ramesh K. Shah and Dusan P. Sekulic, "Fundamentals of Heat Exchanger Design" John Wiley and sons Inc., 2003.

Reference Books:

1. Heat Exchanger Design by Frass & Ozisik, John Wiley and Sons, Newyork, 1997.
2. Convective Heat transfer by Kays and London, Tata McGraw Hill Publication, 1997.
3. ANSI Standards for pipe and nozzle selection, 1996.
4. ASME Section VIII Division for pressure Vessel and Boiler Design Code, 1995.
5. ASME section II, Material Specifications, 1995.
6. D.C. Kern, "Process Heat Transfer", McGraw Hill, 1950.
7. SadikKakac and Hongton Liu, "Heat Exchangers: Selection, Rating and Thermal Design" CRC Press, 1998.
8. A .P. Frass and M.N. Ozisik, "Heat Exchanger Design", McGraw Hill, 1984
9. Afgan N. and Schlinder E.V. "Heat Exchanger Design and Theory Source Book", "T.E.M.A. Standard", New York, 1999.

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Course Code	Course Title	L	T	P	C
2SMTTE4PE3B	**ADVANCED AIR CONDITIONING SYSTEMS**	03	00	00	03

Pre-requisites:

1. An introductory background of thermodynamics is needed.
2. An introductory background of air conditioning is needed.
3. An introductory background of chemistry is needed.

Course Learning Objectives:

1. Design Complex Air Conditioning Systems
2. Optimize Air Conditioning Systems for Energy Efficiency
3. Implement Sustainable Cooling Solutions:

Course Outcomes:

At the end of course, Learner will be able to

1. Demonstrate Proficiency in Psychometric Air Conditioning Analysis
2. Design HVAC Systems for Optimal Comfort Conditions
3. Apply Noise and Vibration Control Techniques
4. Select Air Conditioning Components Effectively
5. Design Piping Systems for Air Conditioning
6. Understand Electrical Circuits and Components in Air Conditioners

	Subject: ADVANCED AIR CONDITIONING SYSTEMS	**L**
UNIT I	Properties of Air Water Mixture, Psychometric Air Conditioning Processes, Dehumidification Processes, Com-fort Air Conditioning, Parameters Affects Comfort Conditions.	6
UNIT II	Cooling Load Calculations, Design Of Air Delivery Sys-tem To Hospital, Auditorium, Hotels Etc.	6
UNIT III	Noise and Vibration Control In Air Conditioning Hall.	6
UNIT IV	Air Conditioning Component Selection (Component Matching), Designing Air Ducts, Window Air Conditioner / Split Air Conditioner Performance Testing.	6
UNIT V	Energy calculations- Degree-Day procedure, Bin Method, Comprehensive Simulation methods method, Flow- Pump - and piping Design.	6
UNIT VI	Electrical Circuits And Components In Air Conditioner Like Olp, Capacitor, Performance Study Of Motors Used For Fan, Blower, Compressor.	6
	Total	36

TEXT BOOKS :

1. Refrigeration and air conditioning, Ahmadul Ameen, Prentice Hall of India, New Delhi, 2006

2. Refrigeration and air conditioning, C P Arora, Tata McGraw-Hill, 2nd ed, 2003

3. Air Conditioning Principles and Systems, E G Pita, Prentice Hall of India, 4th edition, 2005.

REFERENCE BOOKS:

1. The ASHRAE Handbooks with CDs, 2015

2. Refrigeration and Air Conditioning Technology, Tomczyk, J. A., Whitman, W. C., Johnson, W. M., Pub: Delmar S. Africa, 4th edition, 2000.

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Course Code	Course Title	L	T	P	C
2SMTTE4PE3C	**GAS TURBINES & JET PROPULSION**	03	00	00	03

Pre-requisites:

1. Knowledge of gas turbine.

Course Learning Objectives:

1. To study various types of Turbo machinery and Aircraft Propulsion Cycles.
2. To study various Centrifugal Compressors and Axial Flow Turbines.
3. To study various types of Aircraft Jet Engines.
4. To understand Thermodynamics Of Jet Propulsion Subsystems

Course Outcomes:

At the end of course, Learner will be able to

1. Understand the importance and principles of Turbo machinery.
2. Understand the working & applications of Centrifugal Compressors and Axial Flow Turbines. 3. Understand the various types of Aircraft Jet Engines
3. Understand the working principles of Thrust augmentations.
4. Understand the working of Aircraft Jet Engines.
5. Understand Thermodynamics Of Jet Propulsion Subsystems

	Subject: GAS TURBINES & JET PROPULSION	**L**
UNIT I	**General Concepts related to Turbo machinery**: Classification; Euler's Equation for Turbo machinery; Velocity triangle; Cascade analysis & nomenclature. Shaft Power & Aircraft Propulsion Cycles.	6
UNIT II	**Centrifugal Compressors**: Work done and pressure rise; Slip; Compressibility effects; Compressor characteris-tics. Axial Flow Compressors: Stage pressure rise; Blockage in compressor annulus;Degree of reaction; 3- D flow; Stage performance; h-s diagram & efficiency; off design performance; Performance characteristics; Design process. Combus-tion System.	6
UNIT III	**Axial Flow Turbines**: Stage performance; Degree of reaction; h-s diagram & efficiency; Vortex theory; Overall turbine performance; Performance characteristics; Blade cooling; Design process. Prediction of performance of simple gas turbines; Off Design performance; Gas turbine blade materials; matching procedure.	6
UNIT IV	**Combined cycles:** Differences between Single and combined Cycles, characteristics of combined cycles, Performance calculations for Combined Cycle.	6
UNIT V	**Thermodynamics Of Aircraft Jet Engines** Theory of Jet Propulsion - Thrust and efficiency - Ram Jet - Turbojet and Turbofan engines - Turboprop and Turboshaft Engines – Thrust augmentations - Typical engine performance - Engine - Aircraft matching.	6

UNIT VI	**Aero-Thermodynamics Of Jet Propulsion Subsystems** Subsonic inlets - Supersonic inlets - Gas turbine combustors - After burners and Ramjet Combustors -Supersonic Combustion - Exhaust Nozzles.	
	Total	36

TEXT BOOKS:

1. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition,

2. Bonney E.A. Zucrow N.J. Principles of Guided Missile Design, Van Nostranc Co., 1985.

3. S.M. Yahya, Gas Dynamics and Jet Propulsion.

REFERENCE BOOKS:

1. Addition - Wesley Publishing Company, New York, 1992.

2. Zucrow N.J. Principles of Jet Propulsion and Gas Turbines, John

Wiley and Sons Inc, New York, 1970.

3. Zucrow N.J. Aircraft and Missile Propulsion, Vol.I and Vol.II, John

Wiley and Sons Inc, New York, 1975.

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Course Code	Course Title	L	T	P	C
2SMTTE5PE4A	**Fuels and Combustion**	03	00	00	03

Pre-requisites:

1. An introductory background of thermodynamics is needed.
2. An introductory background of IC Engines is needed.
3. An introductory background of chemistry is needed.

Course Learning Objectives: (03)

1. To study the basic concepts of thermodynamics, thermodynamic systems, work and heat
2. To study the laws of thermodynamics and their applications
3. To study the air standard cycles

Course Outcomes: (06)

At the end of course, Learner will be able to

1. Understand the basic concepts of thermodynamics, thermodynamic systems, work and heat
2. Understand the concepts of first law of thermodynamics.
3. Apply first law of thermodynamics during non-flow processes.
4. Apply first law of thermodynamics to flow processes.
5. Understand the concepts of second law of thermodynamics.
6. Understand the concept of air standard cycles

	Subject: Fuels and Combustion	**L**
UNIT I	**Introduction:** General, Conventional Energy Sources, Solar Energy, Nuclear Power, Energy from Biomass, Wind Power, Tidal Power, Geothermal Energy, Energy Survey of India, Rocket Fuels	6
UNIT II	**Solid, Liquid & Gaseous Fuels:** General, Family of Coal, Origin of Coal, Gasification of Coal, Analysis and Properties of Coal, Action of Heat on Coal, Classification of Coal, Oxidation of Coal, Hydrogenation of Coal, Efficient use of Solid Fuels. Manufactured Fuels, Agro Fuels, Solid Fuel Handling, Properties Related to Combustion, Handling Storage	6

UNIT III	**Theory Of Combustion Process:** Origin and Classification of Petroleum, Refining and Other Conversion Processes, Nature of Indian Crudes & Petroleum Refining in India, Liquid Fuels from Other Sources, Storage and Handling of Liquid Fuels, Liquid Fuels Combustion Equipment. Types of Gaseous Fuels, Natural Gases, Manufactured Gases, Producer Gas, Water Gas, Carburetted Water Gas, Blast Furnace Gas Fuels, Through Non- Thermal Route - Biogas, Refinery Gas, LPG, Cleaning and Purification of Gaseous Fuels.	6
UNIT IV	**Stoichiometry:** Stoichiometry and Thermodynamics, Combustion Stoichiometry General, Rapid Methods of Combustion Stoichiometry, Combustion Thermodynamics, Combustion Problems with Chemical Reactions Burners Stoichiometry Relations, Theoretical Air Required for Complete Combustion.	6
UNIT V	Calculation of Minimum Amount of Air Required for a Fuel of known Composition, Calculation of Dry Flue Gases if Fuel Composition is Known, Calculation of the Composition of Fuel & Excess Air Supplied from Exhaust Gas Analysis, Dew Point of Products, Flue Gas Analysis (O 2, CO 2, CO, NO x, SO x).	6
UNIT VI	**Burner Design:** Ignition, Concept of Ignition, Auto Ignition, Ignition Temperature. Flame Propagation, Various Methods of Flame Stabilization, Incorporation in Burner Design, Basic Features and Types of Solid, Liquid and Gaseous Fuel Burner, Design Consideration of Different Types of Coal - Oil and Gas Burners, Recuperative & Regenerative Burners	6
	Total	36

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BOOKS RECOMMENDED:

TEXT BOOK :

1. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990

2. Bhatt ,vora Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 1984

3. Sharma SP, Mohan Chander, Fuels & Combustion, Tata Mcgraw Hill, 1984

REFERENCE BOOKS :

1. Blokh AG, Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn, 1988

2. Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 1966.

M.Tech. Second Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
2SMTTE5PE4B	**CRYOGENICS**	03	00	00	03

Pre-requisites:

1. An introductory background of Maths(calculus) is needed.
2. An introductory background of Physics is needed.
3. An introductory knowledge of Thermodynamics and Refrigeration & Air conditioning are needed.

Course Learning Objectives:

1. To enable the students to analyze and solve cryogenics related problems by applying principles of mathematics, science and engineering.
2. To prepare students to use modern tools, techniques and skills to fulfill industrial needs related to low temperature system and develop skills in the analysis of cryogenics systems in research or design.
3. To develop a professional approach to lifelong learning in the refrigeration/air conditioning/cryogenics to include the awareness of social and environment issues associated with engineering practices

Course Outcomes:

At the end of course, Learner will be able to

1. Apply knowledge of mathematics, science, and engineering for the needs in Cryogenic.
2. Analyze different Cryogenic systems.
3. Evaluate and interpret the analysis reports in the field of Cryogenic.
4. Understand the Cryogenic Fluid Storage, Handling, Insulation, Instrumentation & Vacuum Technology
5. Analyze the study of different instrumentation & safety in the field of cryogenic.
6. Understand the various applications of cryogenics.

	Subject: CRYOGENICS	**L**
UNIT I	**Introduction To Cryogenic Systems:** Introduction, properties of cryogenic fluids, properties of materials used in cryogenics at lower temperature, superconductive materials, applications of cryogenics, cryogenic space technology, space simulation, cryogenics in biology & medicines.	6
UNIT II	**Gas Liquefaction Gas Separation and Purification:** Gas separation and purification – principles, Gas separation systems**:** Gas liquefaction & refrigeration systems, Basics of refrigeration & liquefaction, ideal thermodynamic cycle, Joule Thomson effect, adiabatic expansion, various liquefaction cycles, Liquefaction systems for air, Neon, Hydrogen & Helium gas, Effect of components' efficiencies on system performance for air, hydrogen, and helium.	6

UNIT III	**Cryogenic Refrigeration Systems::** Cryogenic refrigeration systems, Ideal and practical systems, Joule-Thompson cryocoolers, Stirling Cycle Refrigerators, Gifford-McMahon Cryocoolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Dilution refrigerators, Cryostat, Cryo Coolers.	6
UNIT IV	**Cryogenic Fluid Storage, Handling, Insulation, Instrumentation & Vacuum Technology:** Cryogenic Dewar, Cryogenic Transfer Lines, Two phase flow in cryogenic transfer system, Insulations used in Cryogenic Systems Temperature, Pressure, Flow rate and Liquid level measurement, Cryogenic storage vessels, Dewar and large tanks, Storage and transport of LNG and other liquefied industrial gases. Liquid hydrogen storage and transport for hydrogen-fueled vehicle. Special 6insulation requirements at low temperatures, insulating materials. Need of vacuum, various vacuum pumps.	6
UNIT V	**Instrumentation and safety:** Instrumentation in cryogenics to measure Flow, Level and Temperature, Introduction to vacuum technology, safety in cryogenics	6
UNIT VI	**Applications:** Space technology, In-Flight air separation and collection of LOX, Gas industry, Biology, Medicine, Electronics.	6
	Total	36

BOOKS RECOMMENDED:

Text Books:

1. Barron. R.F. Cryogenic Systems, McGraw-Hill, 2nd edition 1985.
2. Cryogenic Engineering Intelligence T.M.Flynn, MarcelDekker CRC Press 2 nd edition, 2004
3. Cryogenics: Applications and Progress A.Bose and P.Sengupta Tata McGraw Hill 1987

Reference Books:

1. Thomas M. Flynn, “Cryogenic Engineering”, Marcel Dekker. Inc New York illustrated edition 1997.
2. Marshall Sittig, D. Van Nostrand Co. “Cryogenics - Research and Applications”, Princeton N.J, Van Nostrand . 1963Scott, R. B, Cryogenic Engineering, Scott, R. B. D’Van-Nostrand, 1962.
3. Vance, R. W., Applied Cryogenic Engineering, , John Wiley and sons, 1st edition 1962.
4. M. Sitting , “Cryogenic”, D’ Van-Nostrand company, 1st edition 1963
5. Cryogenic Systems R.Barron McGraw-Hill Inc 1967

M.Tech. Second Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
2SMTTE5PE4C	**COMPUTATIONAL FLUID DYNAMIC**	03	00	00	03

Pre-requisites:

1. Basic knowledge about CAD Modeling.
2. Basic knowledge about governing equations.
3. Basic knowledge about linear differential equation.

Course Learning Objectives:

1. To numerically solve governing partial differential equations for physical problems in fluid mechanics and heat transfer.
2. To analyze different mathematical models and computational methods for transport processes.
3. To study, and apply discretization methods & schemes and analyze its effect on the accuracy of numerical solution and computational time.
4. To demonstrate the ability to use modern CFD software tools.

Course Outcomes:

At the end of course, Learner will be able to

1. Numerically solve the governing partial differential equations of fluid flow and heat transfer problems.
2. Construct and solve the different mathematical models and computational methods for fluid flows.
3. Apply the discretization methods to solve fluid flow and heat transfer problems.
4. Choose and justify the CFD schemes for the respective fluid flow/transport phenomena problem.
5. Perform verification and validation of numerical model
6. Evaluate the initial and Boundary Value Problems

	Subject: COMPUTATIONAL FLUID DYNAMIC	**L**
UNIT I	**Review of Governing Equations:** Governing Equations of Fluid flow and heat transfer, review of numerical methods.	6
UNIT II	**Discretization:** Introduction to finite differences, difference equations, explicit and implicit approaches: definition and contrasts, errors and analysis of stability.	6
UNIT III	**Classification of Partial Differential Equations:** Explicit and Implicit methods, solution of select model equations; Laplace heat and wave equation, laminar boundary layer solution	6

UNIT IV	**CFD Techniques:** The lax -wendroff technique, Mac Cormack's technique, Relaxation technique and its use with low speed inviscid flows, aspects of numerical dissipation and dispersion; artificial viscosity	6
UNIT V	**CFD Techniques:** Alternating Direction Implicit (ADI) technique, pressure correction technique with application to incompressible viscous flow.	6
UNIT VI	**Initial and Boundary Value Problems:** Free falling of a spherical.	6
	Total	36

BOOKS RECOMMENDED:

TEXT BOOKS :

1. Computational Fluid Flow and Heat Transfer, Muralidhar, K. and Sundararajan, T., Narosa Pub., 2004.
2. Computational Fluid Dynamics: The Basics with Applications, Anderson, J. D., Jr. McGraw Hill, 2002.
3. Computational Fluid Dynamics: An Introduction for Engineers, Abbot, M. B. and Basco, D. R., John Wiley & Sons, 2006.
4. Computational Fluid Dynamics: Principles and Applications, Blazek, J., Elsevier Science, 2001.

M.Tech. Second Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
2SMTTE6	**Advanced Internal Combustion Engines - Lab**	00	00	02	01

Pre-requisites:

1. An introductory background of thermodynamics is needed.
2. An introductory background of IC Engines is needed.

Course Learning Objectives:

1. To learn the working of different IC Engines and components.
2. To learn pollutant formation, control, alternate fuel etc.
3. To learn alternative fuels and Recent trends

Course Outcomes:

At the end of course, Learner will be able to

1. Understand and analyze the fundamentals of combustion, thermodynamics of combustion, different combustion processes,
2. Apply knowledge to solve simple/advance numerical problem of a combustion system
3. Ability to analyze and design a combustion system such as furnace and burner

At least Five practical's based on syllabus of Advanced Internal Combustion Engines.

M.Tech. Second Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
2SMTTE7	**Advanced Refrigeration Engineering - Lab**	00	00	02	01

Course Learning Objectives (CLOs)

1. Identify the basic components of a refrigeration cycle. Obtain cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems.
2. Study of various types of refrigeration systems for various applications like ice plant, water cooler etc.
3. Understand the basic air conditioning processes and study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

Course Outcome (COs)

1. Understand the fundamental basics of simple vapour compression system, types of refrigerants used in refrigearation.
2. Apply the knowledge different application of refrigeration and its controls.
3. Apply the concept of air conditioning system.

Practicals:

1. To study of analysis of actual vapour compression refrigeration system.
2. To study of vapour absorption refrigeration system.
3. Trial on cascade refrigeration system.
4. To study of non-conventional refrigeration system.
5. To study of thermodynamic properties of refrigerant.
6. To study of air refrigeration system.
7. Trial on vortex tube.
8. To study of various refrigeration component.

M.Tech. Second Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
2SMTTE8	**Solar Energy - Lab**	00	00	02	01

Pre-requisites:

Knowledge of energy conversion & renewable sources

Course Learning Objectives:

CLO1. To study various types of Radiative Properties and Characteristics of Materials.

CLO 2. To study and analyze various types of Solar Thermal Energy Storage

CLO 3. To study various types of Solar Heating & Cooling System.

Course Outcomes:

At the end of course, Learner will be able to

1. Understand and analyze the Radiative Properties and Characteristics of Materials.
2. Understand the working & applications of Solar Thermal Energy Storage
3. Understand the Solar Energy for Industrial Process Heat

At least Five practical's based on syllabus of Solar Energy.

M.Tech. Second Semester (Thermal Engg) AY 2024-25

Course Code	Course Title	L	T	P	C
2SMTTE9	**Mini-Project & Seminar -1**	00	00	04	02

Pre-requisites:

Basic Knowledge of Robotics and Robot Applications

Course Learning Objectives:

CLO 1: To Identify the specific problem and give solution.

CLO 2: To Solve, interpret/ correlate the results and discussions .

Course Outcomes:

At the end of course, Learner will be able to

CO1: Formulate a specific problem and give solution.

CO2: Develop model theoretical/ practical/ numerical form.

CO3: Solve, interpret/ correlate the results and discussions.

CO4: Conclude the results obtained and write the documentation in standard form.

Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original. Mini projects should have inter disciplinary/ industry relevance. The students can select a mathematical modeling based/Experimental investigations or Numerical modeling. All the investigations are clearly stated and documented with the reasons/explanations. All the projects should contain A clear statement of the research objectives, background of work, Literature review, techniques used, prospective deliverables, benefit from this [line of] research, Detailed discussion on results, Conclusions and references.