ANNA UNIVERSITY, CHENNAI

NON- AUTONOMOUS COLLEGES

AFFILIATED TO ANNA UNIVERSITY

M.E. THERMAL ENGINEERING

REGULATIONS 2025

PROGRAMME OUTCOMES (POs):

PO	Programme Outcomes
PO1	An ability to independently carry out research /investigation and development work to solve practical problems
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PROGRAMME SPECIFIC OUTCOMES (PSOS)

PSO	Programme Specific Outcomes
PSO1	Design, develop, and analyze advanced thermal and energy systems for improved efficiency, sustainability, and performance in real-world applications.
PSO2	Develop sustainable and efficient energy solutions by applying emerging technologies with ethical and environmental responsibility.

ANNA UNIVERSITY, CHENNAI

POSTGRADUATE CURRICULUM (NON-AUTONOMOUS AFFILIATED INSTITUTIONS)

Programme: M.E., Thermal Engineering **Regulations:** 2025

Abbreviations:

BS –Basic Science (Mathematics)

ES – Engineering Science (General (**G**), Programme Core (**PC**), Programme Elective (**PE**))

SD – Skill Development

OE – Open Elective

L –Laboratory Course

T – Theory

LIT –Laboratory Integrated Theory

PW – Project Work

TCP –Total Contact Period(s)

Semester I

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	MA25C06	Applied Mathematical and Statistical Modelling	T	3	1	0	4	4	BS
2.	TE25C01	Advanced Thermodynamics	LIT	3	0	2	5	4	ES (PC)
3.	TE25C02	Advanced Fluid Mechanics and Heat Transfer	LIT	3	0	2	5	4	ES (PC)
4.	TE25C03	Instrumentation and Control for Thermal Systems	T	3	0	0	3	3	ES (PC)
5.	TE25C04	Fuels and Combustion	LIT	3	0	2	5	4	ES (PC)
6.	TE25C05	Technical Seminar	-	0	0	2	2	1	SD
TOTAL							**24**	**20**	

Semester II

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.		Computational Fluid Dynamics	LIT	3	0	2	5	4	ES (PC)
2.		Modelling and Analysis of Thermal Systems	T	3	0	0	3	3	ES (PC)
3.		Design of Heat Exchangers	T	3	0	0	3	3	ES (PC)
4.		Applied Sustainability Engineering	T	2	0	0	2	2	ES (PC)
5.		Industry Oriented Course I	-	1	0	0	1	1	SD
6.		Programme Elective - I	T	3	0	0	3	3	ES (PE)
7.		Programme Elective - II	T	3	0	0	3	3	ES (PE)
8.		Self-Learning Course	-	-	-	-	-	1	-
						TOTAL	**20**	**20**	

Semester III

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.		AI for Energy Systems	T	3	0	0	3	3	ES (PC)
2.		Programme Elective-III	T	3	0	0	3	3	ES (PE)
3.		Programme Elective-IV	T	3	0	0	3	3	ES (PE)
4.		Open Elective	T	3	0	0	3	3	--
5.		Industry Oriented Course II	-	1	0	0	1	1	SD
6.		Project Work I	-	0	0	12	12	6	SD
7.		Industrial Training	-	-	-	-	-	2	SD
						TOTAL	**25**	**21**	

Semester IV

S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.		Project Work II	---	0	0	24	24	12	SD
						TOTAL	**24**	**12**	

PROGRAMME ELECTIVE COURSES (PE)

S. No.	Course Code	Course Title	Periods Per Week			Total Contact Periods	Credits
			L	T	P		
1.		Modern Power Plants	3	0	0	3	3
2.		Turbomachines	3	0	0	3	3
3.		Waste to Energy	3	0	0	3	3
4.		Polygeneration Systems	3	0	0	3	3
5.		Automotive Systems	3	0	0	3	3
6.		Thermal Management in Electronics and Batteries	3	0	0	3	3
7.		Hydrogen Energy and Fuel Cell Technology	3	0	0	3	3
8.		Hybrid and Electric Vehicles	3	0	0	3	3
9.		Machine Learning in IC Engines	3	0	0	3	3
10.		Energy Storage Technologies	3	0	0	3	3
11.		Solar Photovoltaic Technology and Systems	3	0	0	3	3
12.		Carbon Sequestration and Utilisation	3	0	0	3	3
13.		Refrigeration Systems	3	0	0	3	3
14.		Air-Conditioning Systems	3	0	0	3	3
15.		Energy Audit in Thermal and Electrical Utilities	3	0	0	3	3
16.		Sustainability in Buildings	3	0	0	3	3
17.		Air & Chilled Water Systems for HVAC Applications	3	0	0	3	3
18.		Low Temperature Refrigeration Systems	3	0	0	3	3
19.		Gas Dynamics and Space Propulsion	3	0	0	3	3
20.		Renewable Energy Technology	3	0	0	3	3

Semester I

MA25C06	Applied Mathematical and Statistical Modelling	L	T	P	C
		3	1	0	4

Course Objectives:

- To equip students with advanced mathematical techniques, specifically Fourier Transforms, for formulating and solving partial differential equations that model fundamental mechanical engineering phenomena such as heat transfer, vibrations, and fluid flow.
- To provide a strong foundation in statistical inference, enabling students to estimate population parameters (like material properties and process capabilities) from experimental data and assess the quality and reliability of these estimators.
- To enable students to design efficient, structured experiments and apply appropriate statistical tests to make valid, data-driven decisions for comparing processes, optimizing designs, and solving complex engineering problems.

Fourier Transform: Definitions, Properties, Transform of elementary functions, Dirac delta function, Convolution theorem, Parseval's identity, Solutions to partial differential equations: Heat equation, Wave equation, Laplace and Poison's equations.

Estimation Theory: Unbiasedness, Consistency, Efficiency and sufficiency, Maximum likelihood estimation, Method of moments.

Testing of Hypothesis: Sampling distributions, small and large samples, Tests based on Normal, t, Chi square, and F distributions for testing of means, variance and proportions, Analysis of r x c tables, Goodness of fit, independent of attributes.

Design of Experiments: Analysis of variance, One way and two-way classifications, Completely randomized design, Randomized block design, Latin square design, 2^2 Factorial design.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%.

References:

1. Andrews, L. C., & Shivamoggi, B. K. (2003). Integral transforms for engineers. Prentice Hall of India.
2. Devore, J. L. (2014). Probability and statistics for engineering and the sciences, Cengage Learning.
3. Johnson, R. A., Miller, I., & Freund, J. (2015). Miller and Freund's probability and statistics for engineers, Pearson Education Asia.

E-resources:

1. https://www.edx.org/learn/probability-and-statistics/massachusetts-institute-of-technology-probability-the-science-of-uncertainty-and-data
2. https://www.itl.nist.gov/div898/handbook/
3. https://ocw.mit.edu/courses/2-830j-control-of-manufacturing-processes-sma-6303-spring-2008

TE25C01	Advanced Thermodynamics	L	T	P	C
		3	0	2	4

Course Objectives:

To develop the ability to apply thermodynamic principles for analyzing energy systems and cycles using theoretical, experimental, and simulation approaches.

Thermodynamic Laws and Systems: Thermodynamics Laws and processes, Closed & Open Systems, Steady-state operations, Second Law efficiency.

Practical: Verification of First Law using Calorimeter, Experiment on Heat Work Interaction in Closed System (P-V diagram plotting)

Availability: Available Work: Non-flow and steady flow processes, Entropy Generation Mechanisms, Entropy Minimization Techniques, Exergy of fuels, Combustion Process and Exergy, Exergy Analysis in Heat exchangers, Boilers, Heat pumps, Turbomachines, Internal combustion Engines.

Practical: Entropy Generation in Flow through Pipe (Friction Loss Measurement), Exergy Analysis of a Heat Exchanger (Shell & Tube setup), Fuel Combustion Calorific Value Analysis using Bomb Calorimeter, Software Simulation: Exergy analysis using Software.

Ideal & Real Gas Mixtures: Van der Waals Equation of state, Virial Equations, Maxwell Relations, Joule–Thomson Coefficient, Thermodynamic Relations, Real gas mixtures

Practical: Virtual demonstration of Joule-Thomson Expansion Experiment (Throttle Valve Setup.

Thermodynamic Cycles: Rankine, Kalina, Supercritical and Gas Cycles, Refrigeration & Heat Pump Cycles, Combined Cycle and Cogeneration Systems.

Practical: Performance Test on a Vapour Compression Refrigeration Unit, Virtual simulation of mini powerplant and associated thermal cycles.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)

References:

1. Bejan, A. (2016). Advanced engineering thermodynamics. John Wiley & Sons.
2. Annamalai, K., Puri, I. K., & Jog, M. A. (2011). Advanced thermodynamics engineering. CRC Press.
3. Kuo, K. K. (2005). Principles of combustion. John Wiley & Sons.
4. Wark, K., Jr. (1995). Advanced thermodynamics for engineers. McGraw-Hill.
5. Borel, L., &Favrat, D. (2010). Thermodynamics and energy systems analysis: From energy to exergy. CRC Press.

E-Resources:
https://ocw.mit.edu/courses/mechanical-engineering/2-05-thermodynamics-fall-2003/ https://www.youtube.com/@LearnEngineering https://nptel.ac.in/courses/112/105/112105275 https://ocw.tudelft.nl/courses/thermodynamics/ https://nptel.ac.in/courses/112/103/112103231 https://www.coursera.org/learn/energy-systems https://dwsim.org/

	Description of CO	Mapped POs	PSO1	PSO2
CO1	Describe the Advanced Concepts of thermodynamics for design and analysis of thermal systems	PO3 (3)	3	–
CO2	Evaluate entropy generation, exergy, and availability in energy systems and combustion processes.	PO1 (3), PO3 (3)	3	3
CO3	Analyze real gas behavior at various conditions.	PO1 (2), PO2 (3), PO3 (3)	3	–
CO4	Simulate the performance of advanced thermodynamic cycles and energy conversion systems using software and interpret data.	PO1 (3), PO2 (3), PO3 (3)	3	3

TE25C02	Advanced Fluid Mechanics Heat Transfer	L	T	P	C
		3	0	2	4

Course Objectives:
To provide knowledge and skills to analyze and apply principles of fluid mechanics and heat transfer, Including conduction, convection, phase change, and advanced applications, through theoretical study, experimental investigation, and computational techniques.

Fluid Kinematics and Boundary Layer Theory: 3D Governing Equations: Mass, momentum and applications, Rotational & irrotational flows, stream & potential functions, Vorticity, flow visualization concepts, Velocity Boundary layer theory: displacement, momentum & energy thickness,Laminar and turbulent boundary layers (flat plate & circular pipe)

Practical: Measurement of boundary layer thickness over a flat plate in a wind tunnel, Determination of velocity profile for laminar/turbulent flow using Pitot tube.

Fluid Flow Analysis: Laminar flow: parallel plates and circular pipes, Friction factor, smooth vs rough pipes, Moody diagram, Minor and major losses, pipes in series/parallel, Power transmission through pipes,1D compressible flow in variable area ducts,Nozzles and diffusers, choking and flow regimes

Practical: Flow rate measurement in pipes using venturi/mass flow meters, Determination of friction factor using Moody's chart, Losses in pipe systems (major & minor losses), experimental setup

Conduction: Boundary Conditions, Thermal Conductivity, Conduction equation, Fin Design, analytical solutions, Multi-dimensional steady state heat conduction, Transient Heat conduction, Lumped Capacitance Method, Semi-Infinite Media Method

Practical:
Thermal conductivity of solids & liquids and effect of temperature, Thermal analysis of fins, Lumped heat method for analysis of different geometries

Convection: Energy & Momentum equations, Laminar & Turbulent Boundary Layers, Entry length, Reynolds-Colburn Analogy, Heat transfer coefficient for flow over a flat surface, circular & non-circular ducts

Practical:
Thermal & hydraulic boundary layer development through fluid, Free & Forced convective heat transfer coefficient studies.

Two-Phase Heat Transfer

Pool & Convective boiling, critical heat flux, Dropwise & filmwise condensation, Melting & Solidification, Heat transfer enhancement methods.

Practical:
Plotting of boiling & condensation curves, T-t plots during melting & solidification

Thrust Areas: Thermoregulation, Laser Generated Heat Transfer, Tissue Thermal Properties and Perfusion, Thermal Damage and Rate Processes in Biologic Tissues, Thermal Injury, Mathematical models of bio-heat transfer

Machine Learning in Heat Transfer, Linear regression and Neural networks, Practical considerations & Applications. **Practical:** Irradiation studies & heat generation from lasers
Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%
Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)
References: 1. Çengel, Y. A., & Cimbala, J. M. (2018). *Fluid mechanics: Fundamentals and applications*. McGraw-Hill. 2. White, F. M. (2016). *Fluid mechanics*. McGraw-Hill Education. 3. Lienhard, J. H., IV, & Lienhard, J. H., V. (2020). *A heat transfer textbook*. Phlogiston Press. 4. Holman, J. P. (2002). *Heat transfer*. Tata McGraw-Hill. 5. Çengel, Y. A. (2020). *Heat and mass transfer: Fundamentals and applications*. McGraw-Hill. 6. Incropera, F. P., & DeWitt, D. P. (2002). *Fundamentals of heat and mass transfer*. John Wiley & Sons.
E-Resources: https://nptel.ac.in/courses/112105269?utm_ https://www.youtube.com/playlist?list=PLbMVogVj5nJTZJHsH6uLCO00I-ffGyBEm&utm https://onlinecourses.nptel.ac.in/noc25_me171/preview?utm https://onlinecourses.nptel.ac.in/noc23_ch32/preview?utm

	Description of CO	Mapped POs	PSO1	PSO2
CO1	Describe the principles of fluid mechanics to analyze flow behavior, boundary layers, and pressure/velocity variations in internal and external flows.	PO3 (3)	3	–
CO2	Evaluate fluid flow parameters, frictional losses, and compressible flow behavior in ducts, nozzles, and diffusers through theoretical and experimental studies.	PO1 (2), PO3 (3)	3	–
CO3	Analyze heat transfer by conduction, convection, and phase change, and validate models using experimental investigations.	PO1 (3), PO2 (2), PO3 (3)	3	3
CO4	Utilize computational and modern techniques, including machine learning, to simulate advanced heat transfer and bio-heat transfer processes for sustainable applications.	PO1 (3), PO2 (3), PO3 (3)	3	3

TE25C03	Instrumentation and Control for Thermal Systems	L	T	P	C
		3	0	0	3

Course Objectives:

To provide knowledge and skills in experimental methods, measurement systems, and industrial automation for accurate data acquisition, analysis, and process control.

Experimental Methods: Statistical and regression analysis, uncertainty and data reduction, experimental design, basics of data analytics and machine learning.

Activities: Mini-project on regression and uncertainty analysis using software, Design of Experiments (DoE) simulation using Taguchi method, Introduction to Python/R for basic data analytics.

Sensors, Transducers and Calibration: LVDT, strain gauge, capacitive, piezoelectric, optical and magnetic transducers; thermocouple, RTD, thermistor; calibration of sensors; electronic, fibre-optic and pneumatic transmitters; telemetry.

Activities: Lab experiments using LVDT, strain gauge, and thermocouples, Sensor signal acquisition and visualization via DAQ systems, Calibration experiments with standard temperature and pressure instruments

Measurements in Thermal Systems: Temperature, pressure, and flow measurements, Measurement of: Thermal conductivity, Specific heat, Viscosity, Rheological analysis of Newtonian and non-Newtonian fluids, Humidity, Solar irradiation, Differential Scanning Calorimetry, Calorific values of fuels (solid, liquid, gas)

Activities: Measurement of temperature, pressure, flow using industrial instruments, Determination of thermal conductivity and specific heat in the lab, Analysis using Differential Scanning Calorimetry (DSC)

Control Systems and Industrial Automation: Open/closed loop systems, transfer functions, feedback, signal conditioning, DAQ, PID and PLC controllers, regulators, thermostats, drives, SCADA, DCS, IIoT, and system optimisation.

Activities: Simulation of PID control using software, PLC programming using ladder logic (e.g., Siemens, Allen-Bradley), Hands-on with SCADA/DCS platforms (demo setups or software simulators), Virtual labs on IIoT and remote monitoring systems

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)

References:

1. Holman, J. P. (2011). Experimental methods for engineers. Tata McGraw-Hill.
2. Doebelin, E. O. (2004). Measurement systems: Application and design. McGraw-Hill.
3. Kirkup, L. (2019). Experimental methods for science and engineering students. Cambridge University Press.
4. Morris, A. S., &Langari, R. (2015). Measurement and instrumentation: Theory and application. Elsevier.
5. Anderson, N. A. (2017). Instrumentation for process measurement and control.

CRC Press.
6. Datta, A., & Goel, P. (2023). Practical guide to instrumentation, automation and robotics. Elsevier.
7. Lipták, B. G. (Ed.). (2018). Instrument engineers' handbook: Process measurement and analysis. CRC Press.

E-resources and Other Resources:

https://nptel.ac.in/courses/106/106/106106179/
https://nptel.ac.in/courses/108/105/108105062/
https://nptel.ac.in/courses/112/104/112104906/
https://nptel.ac.in/courses/108/101/108101037/
https://nptel.ac.in/courses/108/105/108105062/

	Description of CO	**Mapped POs**	**PSO1**	**PSO2**
CO1	Describe the experimental methods, statistical analysis, and data analytics for accurate investigation of thermal systems.	PO1 (3), PO2 (2)	3	–
CO2	Demonstrate the use of sensors, transducers, and advanced measurement systems for thermal parameters.	PO3 (3)	3	–
CO3	Design and implement control and automation\strategies (PID, PLC, SCADA, IIoT) for efficient and sustainable thermal system operations.	PO1 (3), PO2 (3), PO3 (3)	3	3

TE25C04	Fuels and Combustion	L	T	P	C
		3	0	2	4

Course Objective

To introduce the principles of combustion, stoichiometry, flame behavior, and thermodynamics across solid, liquid, and gaseous fuels and to emphasize the analysis of combustion systems, emissions, and safety, with a focus on modern fuel technologies and sustainable energy application

Combustion Fundamentals and Stoichiometry: Combustion types and mechanisms, stoichiometry and flame characteristics, ignition, flame stabilization and combustion kinetics, flue gas analysis

Practical: Estimation of calorific value using bomb calorimeter, orsat gas analysis for flue gases, determination of air-fuel ratio for a given fuel.

Solid Fuels: Solid fuel types, properties and analysis, carbonization, gasification, and liquefaction, advanced biomass processing and hybrid fuels

Practical: Proximate and ultimate analysis of coal/biomass, study of fixed bed gasifier setup, fuel handling and briquetting of biomass

Liquid and Gaseous Fuels: Refining and testing of liquid fuels, synthetic fuels, bio, and alternative fuels, gaseous fuels: properties, production, and applications

Practical: Flash point and fire point testing (Pensky-Martens apparatus),Kinematic viscosity testing using redwood viscometer, measurement of octane and cetane numbers (engine method/demo)

Combustion Devices: Burners for fuels, pulverized fuel, furnaces and fluidized beds, low-NOx and smart burner technologies.

Practical: Performance testing of bunsen/industrial burner, design of a simple liquid/gas fuel burner, combustion efficiency measurement, flame visualization using high-speed camera/schlieren methods (demo or project)

Emissions and Combustion Safety: Emission sources, measurements and control, sensors, safety in fuel storage and combustion systems.

Practical: Measurement of NOx, SOx, CO, and particulate matter, study of fire extinguishing systems and combustion safety protocols

Combustion Sustainability: Green Fuels**:** hydrogen, ammonia, bio-fuels, and carbon-neutral fuels, AI/IoT in combustion optimization, emission reduction strategies, carbon capture in combustion systems, lean premixed combustion.

Practical: Performance evaluation of engine on biodiesel, Combustion of hydrogen or ammonia (simulation or demo setup), IoT-enabled emission monitoring, life cycle assessment (LCA) of biofuels, simulation of oxy-fuel combustion in software.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)

References:

1. Sarkar, S. (2009). Fuels and combustion. Orient Longman Pvt. Ltd.
2. Philips, H. J. (2008). Fuels – solids, liquids, and gases: Their analysis and valuation. Biobliolife Publisher.
3. Turns, S. R. (2012). An introduction to combustion: Concepts and applications . Tata McGraw-Hill.
4. Mishra, D. P. (2010). Fundamentals of combustion. University Press.
5. Sharma, S. P., & Mohan, C. (1984). Fuels and combustion. Tata McGraw-Hill.
6. Mukhopadhyay, R., & Datta, S. (2007). Engineering chemistry. New Age International Pvt. Ltd.

E-Resources:

https://nptel.ac.in/courses/112106184
https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/
https://www.coursera.org/learn/energy-production
https://www3.nd.edu/~powers/ame.60636/notes.pdf
https://www.ieabioenergy.com/

Other Resources:

Interactive simulation platforms:
https://vlabs.iitkgp.ac.in/heat/
https://learncheme.com/simulations/thermodynamics/adiabatic-flame-temperature/
https://learncheme.com/quiz-yourself/interactive-self-study-modules/combustion-reactions/
https://www.nist.gov/services-resources/software/fire-dynamics-simulator-fds

	Description of CO	Mapped POs	PSO1	PSO2
CO1	Describe the combustion fundamentals, stoichiometry, and flame behavior concepts to analyze different fuel types.	PO1 (3), PO3 (2)	3	–
CO2	Evaluate properties, testing methods, and performance of solid, liquid, and gaseous fuels including biofuels.	PO1 (3), PO2 (2), PO3(2)	3	–
CO3	Design and analyze combustion devices, emission control techniques, and safety protocols for fuel systems.	PO1 (3), PO2 (3)	3	2
CO4	Assess sustainable and advanced combustion practices for clean energy applications.	PO1 (3), PO3 (3)	–	3