

COURSE TITLE	ENGINEERING THERMODYNAMICS AND HEAT TRANSFER
COURSE CODE	01ML0404
COURSE CREDITS	4

Objective:

- 1 To develop a fundamental understanding of thermodynamic principles and heat transfer mechanisms, and their application in engineering systems. The course aims to enable students to analyze energy conversion processes, power cycles, and different modes of heat transfer. It also focuses on applying theoretical concepts to practical systems such as heat exchangers and thermal equipment.

Course Outcomes: After completion of this course, student will be able to:

- 1 Apply laws of thermodynamics in closed and open systems for various engineering devices
- 2 Analyze performance of vapor and gas power cycles to compare their efficiencies and identify factors influencing cycle effectiveness.
- 3 Apply Fourier's law and thermal resistance concept to calculate heat transfer through plane walls, composite walls, cylinders, and spheres.
- 4 Analyze convective heat transfer using Newton's law of cooling, boundary layer concepts, and dimensionless numbers
- 5 Analyze radiation heat exchange and evaluate heat exchanger performance using LMTD and effectiveness-NTU methods.

Pre-requisite of course: Basic knowledge of Engineering Physics, Engineering Mathematics, and introductory programming concepts for data analysis.

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	Laws of Thermodynamics and Entropy Zeroth law, First law for closed system, Internal energy - a property of system, Steady flow energy equation, Application of SFEE: Nozzle, Diffuser, Boiler, Turbine, Pump, Heat Exchanger, Throttling process, Limitations of first law, Thermal Energy Reservoir, Heat Engine, Heat Pump and Refrigerator, Kelvin-Planck and Clausius Statements and their equivalence, Reversibility and Irreversibility, Clausius Theorem, Entropy-A Property of System, Inequality of Clausius, Causes & types of Irreversibility, Condition for Reversibility, Entropy Change in Irreversible Process.	12

Contents : Unit	Topics	Contact Hours
2	Vapour Power and Gas Power Cycle Carnot cycle, Rankine Cycle, Efficiency Calculation of Rankine Cycle, Air standard Efficiency of Otto cycle and diesel cycle.	8
3	Heat Conduction Modes of heat transfer: conduction, convection and radiation, Difference between thermodynamics and heat transfer, Fourier's law of heat conduction, Thermal conductivity and thermal diffusivity, General heat conduction equation, Heat conduction through plane and composite walls, Heat conduction through cylinders and spheres, Thermal resistance concept, Critical radius of insulation	8
4	Convection Heat Transfer Newton's law of cooling, Natural and forced convection, Boundary layer concept, Dimensionless numbers: Reynolds, Nusselt, Prandtl and Grashof numbers, Dimensional analysis in convection, Empirical correlations for natural and forced convection	7
5	Radiation and Heat Exchangers Thermal radiation fundamentals, Blackbody radiation, Stefan–Boltzmann law, Kirchhoff's law, Radiation heat exchange between surfaces, Shape factor concept, Types of heat exchangers, Parallel flow and counter flow heat exchangers, Log Mean Temperature Difference (LMTD), Overall heat transfer coefficient, Effectiveness–NTU method	7
Total Hours		42

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	Experiment 1 To determine coefficient of performance of the vapour compression refrigeration system.	2
2	Experiment 2 To perform experiment on four stroke petrol engine	2
3	Experiment 3 To determine the thermal conductivity of the given composite walls.	2
4	Experiment 4 To determine heat transfer co-efficient by natural convection.	2
5	Experiment 5 To determine the emissivity of the test plate.	2
6	Experiment 6 To determine the overall heat transfer co-efficient of tube and tube type heat exchangers.	2
7	Experiment 7 To determine the overall heat transfer co-efficient of shell and tube type heat exchangers.	2

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
8	Experiment 8 To analyze the conduction heat transfer in plane wall using ANSYS.	2
9	Experiment 9 To analyze the conduction heat transfer in composite wall using ANSYS.	2
10	Experiment 10 To analyze the conduction heat transfer in hollow cylinder using ANSYS.	2
11	Experiment 11 Prediction of thermal conductivity of materials using machine learning.	2
12	Experiment 12 Prediction of heat transfer rate through a wall using temperature difference data and machine learning.	2
Total Hours		24

Textbook :

- 1 Engineering Thermodynamics, P. K. Nag, McGraw Hill Education, 2021
- 2 Heat and Mass Transfer, D. S. Kumar, S. K. Kataria & Sons, 2020
- 3 Heat and Mass Transfer, R. K. Rajput, S. Chand Publishing, 2023

References:

- 1 Thermodynamics an Engineering Approach, Thermodynamics an Engineering Approach, Y. A. Cengel and M. A. Boles, McGraw Hill Education, 2020
- 2 Heat and Mass Transfer: Fundamentals and Applications, Heat and Mass Transfer: Fundamentals and Applications, Yunus A. Cengel and Afshin J. Ghajar, McGraw Hill Education, 2020
- 3 Fundamentals of Heat and Mass Transfer, Fundamentals of Heat and Mass Transfer, Frank P. Incropera, David P. DeWitt, Theodore L. Bergman and Adrienne S. Lavine, John Wiley & Sons, 2021
- 4 Heat Transfer, Heat Transfer, J. P. Holman, McGraw Hill Education, 2019
- 5 Fundamentals of Engineering Thermodynamics, Fundamentals of Engineering Thermodynamics, Michael J. Moran & Howard N. Shapiro, John Wiley & Sons, 2022

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation

Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
0.00	0.00	55.00	35.00	10.00	0.00

Instructional Method:

- 1 Power Point Presentation Method
- 2 Laboratory Experiments

Supplementary Resources:

- 1 https://onlinecourses-archive.nptel.ac.in/noc19_me13/preview
- 2 https://onlinecourses-archive.nptel.ac.in/noc19_ch06/preview