

Branch Name:	Mechanical Engineering
Program Code:	ET101
Course Name:	Heat Transfer and Thermal Machines
Course Code:	2ET1010401T
Pre-requisite Course:	Applied Thermodynamics

Course Objectives:

1. Build a solid foundation in heat transfer, exposing students to the three basic modes namely conduction, convection and radiation.
2. Rigorous treatment of governing equations and solution procedures for the three modes, along with solution of practical problems using empirical correlations.
3. The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours Per Week				Evaluation Scheme (Marks)								
					Theory (Marks)				Practical (Marks)				Total (Marks)
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
04	03	01	-	04	24	60	16	40	-	-	-	-	100

Course Contents:

Sr. No.	Topic	Total Hours	Weightage (%)
1	Introduction: Three modes of heat transfer; Examples of equipment (like air conditioner and air cooler) involving heat transfer; Derivation of heat balance equation.	04	10
2	Conduction Heat Transfer: Steady 1D solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry; Concept of conduction and film resistances; Critical insulation thickness; Lumped system approximation and Biot number; Heat transfer through pin fins; 2D conduction solutions for steady and unsteady heat transfer.	08	20
3	Convection Heat Transfer: Basic equations; Boundary layers; Forced convection; External and internal flows; Natural convective heat transfer; Dimensionless parameters for forced and free convection heat transfer; Correlations for forced and free convection; Approximate solutions to laminar boundary layer equations for internal and external flow; Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.	08	20

4	Radiation Heat Transfer: Interaction of radiation with materials; Definitions of radiative properties; Stefan Boltzmann's law; Black and grey body radiation; Calculation of radiation heat transfer between surfaces using radiative properties; View factors and the radiosity method; Examples for two-body enclosures; Radiation shield.	08	20
5	Heat Exchanger Design: Function, classification and configuration of heat exchangers; Evaluation of mean temperature difference; Heat exchanger effectiveness; Analysis, design and selection of heat exchangers.	08	20
6	Boiling and Condensation Heat Transfer: Pool boiling; Flow boiling; Film and drop wise condensation.	03	05
7	Introduction to Mass Transfer: Analogy between heat and mass transfer; Mass diffusion; Fick's Law; Steady and transient mass diffusion; Simultaneous heat and mass transfer.	03	05

Reference Books:

1. A. Bejan, "Heat Transfer," John Wiley, 1993.
2. J.P. Holman and S. Bhattacharyya, "Heat Transfer," McGraw Hill, 2017.
3. F.P. Incropera, and D.P. Dewitt, "Fundamentals of Heat and Mass Transfer," John Wiley, 2019.
4. Massoud Kaviany, "Principles of Heat Transfer," John Wiley, 2002.
5. Yunus A Cengel, "Heat Transfer: A Practical Approach," McGraw Hill, 2002.
6. Nag P.K. Heat and mass transfer, McGraw Hill.
7. R. K. Rajput, Heat and Mass Transfer, S. Chand Publication.

List of Tutorials:

1. Tutorial on Conduction Heat Transfer.
2. Tutorial on Convection Heat Transfer.
3. Tutorial on Radiation Heat Transfer.
4. Tutorial on Heat Exchanger Design.
5. Tutorial on Boiling and Condensation Heat Transfer.
6. Tutorial on Mass Transfer.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc22_ch65/preview
2. <http://nptel.ac.in/courses/103103032>

Course Learning Outcomes (CLO):

CLO	Description	Bloom's Taxonomy Level
CLO1	Understand basic concept and importance of heat transfer for a mechanical engineer.	1 Remembering 2 Understanding
CLO2	Able to classify and solve problems related to steady state, extended surfaces and unsteady state conduction.	3 Applying 5 Evaluating
CLO3	Formulate and analyze a heat transfer problem involving any of the three modes of heat transfer	2 Understanding 4 Analyze
CLO4	Understand basics and importance of radiation heat transfer, laws of radiation.	2 Understanding 3 Applying
CLO5	Design heat exchangers and estimate the insulation needed to reduce heat losses where necessary.	3 Applying 5 Evaluating
CLO6	Obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer	2 Understanding 6 Creating

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CLO1	M		L				M					M		
CLO2	H	M	M	M	M								L	
CLO3	H	H		H								M	L	
CLO4	H	M	H	M	M	L	M							
CLO5	L		H	M	H							M		
CLO6	M	L	M	L	M							M		

H: High, M: Medium, L: Low