



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Mechanical Engineering

Subject Code: DI05019071

Subject Name: Heat and Mass Transfer

W. e. f. Academic Year:	2026-27
Semester:	5 th
Category of the Course:	PEC-04

Prerequisite:	(1) Elements of Mechanical Engineering (DI01000191) (2) Engineering Thermodynamics (DI03019011) (3) Thermal Engineering – I (DI04019011)
Rationale:	This course equips diploma engineering students with essential heat and mass transfer skills needed in industries like power, HVAC, automotive, and chemical processing. Students learn to calculate conduction heat loss through walls, pipes, and fins. Similarly, learn about convective heat transfer coefficients and their use with dimensionless numbers in industrial problems. They also learn to apply radiation laws to furnaces and solar systems. Furthermore, they learn to analyze heat exchangers using LMTD and effectiveness methods. Finally, the students will learn to solve diffusion problems using Fick's Law and mass transfer coefficients. Together, these competencies enable graduates to design, troubleshoot, and improve thermal equipment commonly encountered in real-world engineering practice.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes
CO-1	Calculate heat transfer through plain & composite walls, cylinders, fins and insulation.
CO-2	Calculate heat transfer coefficient for forced and free convection problems.
CO-3	Solve problems involving black, white, and grey bodies, shape factors, and radiation shields.
CO-4	Analyze heat exchangers by calculating the LMTD, the overall heat transfer coefficient, and the effectiveness.
CO-5	Calculate convective mass transfer rates using mass transfer coefficients and law for diffusion.



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Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Conduction 1.1 Fourier's Law 1.2 Thermal conductivity and thermal resistance 1.3 Derivation of one-dimensional steady state conduction 1.4 Heat Conduction through - Plain wall - Composite walls - Cylinders 1.5 Critical radius of insulation for a cylinder 1.6 Overall heat transfer coefficient 1.7 Heat transfer from an extended surface - Types of fins, - Heat flow through a rectangular fin, - Infinitely long fin - Efficiency and effectiveness of fin 1.8 Numerical examples	15	33
2.	Convection 2.1 Newton's law of cooling 2.2 Concept of forced and free convection 2.3 Overall heat transfer coefficient – conduction and convection 2.4 Dimensionless numbers and their physical significance - Reynold's Number, - Prandtl number, - Nusselt Number 2.5 Boundary layer definition and characteristics 2.6 Boundary layer thickness 2.7 Boiling regimes 2.8 General aspects of condensation heat transfer	06	14
3.	Radiation	05	11



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	3.1 Absorptivity, Reflectivity, and Transmissivity 3.2 Black, white, and grey body 3.3 Emissive power and emissivity, 3.4 Laws of radiation - Planck - Stefan – Boltzmann, - Wein’s displacement - Kirchhoff’s law - Lambert’s cosine law 3.5 Concept of shape factor 3.6 Concept of radiation shield 3.7 Numerical examples		
4.	Heat exchanger 4.1 Classification 4.2 Heat exchanger analysis 4.3 LMTD for parallel and counter flow exchanger, condenser and evaporator 4.4 Overall heat transfer coefficient 4.5 Effectiveness of heat exchanger 4.6 Concept of heat pipe and compact heat exchanger 4.7 Numerical examples	14	31
5.	Mass Transfer 5.1 Modes of mass transfer 5.2 Concentrations, velocities and fluxes 5.3 Fick’s Law 5.4 Steady state diffusion through a plain membrane 5.5 Steady state equimolar counter diffusion 5.6 Mass transfer coefficient - Convective mass transfer	05	11
	Total	45	100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
37	38	25	-	-	-

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom’s Taxonomy)



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References/Suggested Learning Resources:

(a) Books:

Sr. No.	Title of Books	Author	Publication & ISBN
1.	Heat and Mass Transfer	R.C.Sachdeva	New age international, New Delhi
2.	Heat and Mass Transfer	R K Rajput	S.Chand & Co., New Delhi
3.	Heat and Mass Transfer	B.K.Venkanna	PHI Learning, New Delhi
4.	Heat and Mass Transfer	Arora & Domkundwar	Dhanpat Rai and Co., New Delhi
5.	Heat and Mass Transfer	D S Kumar	S K Kataria & Sons
6.	Heat and mass transfer	P.K.Nag	McGraw Hill
7.	Heat and mass transfer	J.P.Holman	McGraw Hill

(b) Open-source software and website:

1. <https://ht-nitk.vlabs.ac.in/exp/thermal-conductivity-metal-rod/>
2. <https://ht-nitk.vlabs.ac.in/exp/composite-wall/>
3. <https://ht-nitk.vlabs.ac.in/exp/thermal-conductivity-insulating-material/>
4. <https://ht-nitk.vlabs.ac.in/exp/natural-convection/>
5. <https://ht-nitk.vlabs.ac.in/exp/forced-convection/>
6. <https://ht-nitk.vlabs.ac.in/exp/emissivity-of-surface/>
7. <https://ht-nitk.vlabs.ac.in/exp/stefan-boltzmann-constant/>
8. <https://cpd-iitkgp.vlabs.ac.in/exp/heat-exchanger/>
9. <https://store.epicgames.com/en-US/p/pnx-labs-thermal-fluids-101-0f0679>
10. <https://www.merlot.org/merlot/viewMaterial.htm?id=81819>

Suggested Course Practical List:

1. Determine the thermal conductivity of a given material.
2. Calculate the overall thermal resistance and heat transfer rate through a composite wall.
3. Verify the concept of critical radius of insulation by measuring heat loss from a bare and insulated pipe at varying insulation thicknesses.
4. Calculate the efficiency and effectiveness of fins.
5. Determine the average natural convection heat transfer coefficient.
6. Evaluate the effect of air velocity on the forced convection heat transfer coefficient.
7. Verify the Stefan-Boltzmann law for a black body source at different absolute temperatures.



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8. Compare the performance of a concentric tube heat exchanger in parallel flow versus counterflow configuration by calculating LMTD and overall heat transfer coefficient for each.
9. Calculate the effectiveness of a heat exchanger by varying flow rates.
10. Determine Convective Mass Transfer Coefficient.

List of Laboratory/Learning Resources Required:

1. Thermal Conductivity of Slab Apparatus (Guarded Hot Plate method).
2. Composite Wall Apparatus (with 3-4 different material slabs with thermocouples).
3. Critical Radius of Insulation Apparatus (heated pipe with variable insulation thickness).
4. Pin Fin / Rectangular Fin Apparatus (thermocouples along the length).
5. Free and Forced Convection Apparatus (vertical cylinder/plate heated electrically, with variable speed fan/blower).
6. Stefan-Boltzmann Apparatus.
7. Emissivity Measurement Apparatus.
8. Shell and Tube Heat Exchanger Apparatus (with parallel and counterflow arrangement).
9. Convective Mass Transfer Apparatus (wetted surface, blower, humidity measurement).

Suggested Project List:

1. Prepare a comparative table of the thermal conductivity of locally available materials.
2. Prepare a model of a composite wall using thermocol, plywood, and aluminum foil.
3. Record drying time of wet cloth in still air vs. moving air.
4. Compare the cooling of a hot object in air, water, and oil.
5. Working model of natural convection using a small heater and tissue paper movement.
6. Model of boiling regimes using a transparent container, heater, and small beads.
7. Model of black body and grey body using painted metal balls.
8. Working model of radiation shield using two candles and a metal sheet.
9. Build a simple parallel flow heat exchanger using pipes and buckets (working model/cut section/chart).
10. Build a simple counterflow heat exchanger (working model/cut section/chart).
11. 3D model of parallel flow and counterflow heat exchanger using colored pipes.
12. Scaled model of a shell and tube heat exchanger.
13. Model of diffusion using a glass tube and colored liquid/gas.
14. 3D model of a cooling tower showing mass transfer.

Suggested Activities for Students:

1. Prepare a chart of types of fins (rectangular, triangular, pin fin) with applications.
2. Make a chart of dimensionless numbers (Reynolds, Prandtl, Nusselt) and their formulas.
3. Make a chart showing boiling regimes (natural convection, nucleate, transition, film boiling).
4. Draw a radiation laws comparison chart (Planck, Stefan-Boltzmann, Wien, Kirchhoff).
5. Make a chart of shape factors for different geometries.



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6. Make an LMTD correction factor chart for heat exchangers.
7. Prepare a cut section of a heat pipe (showing wick structure, evaporator, condenser sections).
8. Prepared a cut section of a radiator (showing tubes and fins)
9. Make a chart showing Fick's Law of diffusion.

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