NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech. in Mechanical Engineering
Course Code:	
Course Title:	Heat and Mass Transfer
Course Type:	Core
Year of Introduction:	2024-25

L	**T**	**Practical component**				**C**
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Course Learning Outcomes (CLOs):

After successful completion of the course, the student will be able to:

1	assess the principles of steady and unsteady state heat conduction,	(BL5)
2	interpret the principles of heat transfer by convection, boiling and condensation,	(BL2)
3	apply the concepts of radiation heat transfer for engineering applications,	(BL3)
4	explain the basic principles of heat exchanger design and mass transfer.	(BL2)

Unit	**Contents**	**Teaching Hours (Total 45)**
Unit I	**Conduction** Derivation of generalized equation in Cartesian, Cylindrical and Spherical coordinates, generalized transport equation, one-dimensional steady state heat transfer equations, heat transfer calculations in slabs, cylinders and spheres, use of electrical analogy and estimation of resistance and heat transfer, factors affecting thermal conductivities of various substances, properties of insulation and their importance, critical thickness of insulation. Transient heat conduction in solids – lumped analysis and one-dimensional analysis using Heisler charts. Use of finite difference techniques for solving heat conduction problems.	13

Heat transfer through extended surfaces: Types, arrangement and application, determination of fin temperature and heat transfer, fin effectiveness and fin efficiency.

Unit II **Convection** 08

Dimensionless numbers, concept of hydrodynamics and thermal boundary layers, continuity momentum equation & energy equation, derivation of generalized equation in dimensionless groups for free & forced convection by dimensional analysis and principle of similarity, use of empirical co-relations to determine heat transfer co-efficient in natural and forced convection for parallel, counter and cross flow arrangements.

Unit III **Boiling and Condensation** 04

Boiling curve and modes of pool boiling, flow boiling, film and dropwise condensation, heat pipe.

Unit IV **Radiation** 09

Concept of black and grey surfaces, laws of radiation, Kirchoff's, Stephan–Boltzmann's, Planck's and Wien's laws, emissivity, electrical analogy, heat exchange between black and grey surfaces and enclosed body and enclosure, radiation shield and their effects, use of electrical analogy methods.

Unit V **Heat Exchangers** 08

Types and classification, fouling factors, overall heat transfer coefficient, LMTD calculation for parallel flow, counter flow and cross flow heat exchangers, effectiveness – NTU method, effectiveness and efficiency of heat exchangers, designation of shell and tube heat exchangers as per TEMA standards.

Unit VI **Mass Transfer** 03

Fick's law, equimolal diffusion, diffusion of vapors through stagnant medium, applications.

Self – Study: The self-study content will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content.

Laboratory Work: Laboratory work will be based on above syllabus with a minimum 10 experiments to be incorporated.

Suggested Readings/References:

1. Cengel Y., Ghajar A., Heat and Mass Transfer, McGraw Hill.
2. Incropera F., DeWitt D., Fundamentals of Heat and Mass Transfer, John Wiley.
3. Sukhatme S. P., Heat Transfer, Universities Press.
4. Holman J. P., Heat and Mass Transfer, McGraw Hill.
5. Nellis G. Klein S., Heat Transfer, Cambridge University Press.

Suggested list of experiments: (not restricted to the following)

Sr. No.	Title	Hours
1.	To find thermal conductivity of a material Guarded Hot Plate method.	02
2.	To find the emissivity of a test plate.	02
3.	To find the Stefan-Boltzmann constant.	02
4.	To find the convective heat transfer coefficient in natural convection.	02
5.	To find the convective heat transfer coefficient in forced convection.	02
6.	To find overall heat transfer coefficient in a double pipe heat exchanger.	02
7.	To find overall heat transfer coefficient in a shell and tube heat exchanger.	02
8.	To find mass diffusion coefficient.	02
9.	To demonstrate the construction and performance of heat pipe.	02
10.	To find critical heat flux in pool boiling heat transfer	02
11.	To study the performance of solar flat plate collector.	02