Heat and Mass Transfer

Code	Credit Hours
ME- 237	3-1

Course Description:

This course aims to develop the basic understanding and application of heat and mass transfer principles related to the engineering field. All three modes of heat transfer are covered in detail with main emphasis on types and variants related to conduction and convection. The course is meant to prepare students to use the subject matters in analyzing and solving the real life heat transfer problems. In this course the students also performs many lab experiments to verify the basic laws of heat transfer.

Text Book:

1. Heat and Mass Transfer: Fundamentals and Applications Latest Available Edition by Yunus Cengel (Author), Afshin Ghajar (Author)

Reference Books:

1. "Fundamentals of Heat Transfer", by F.P. Incropera & D.P. Dewitt
2. "Heat Transfer" by J.P. Holman

Prerequisites

Engineering Thermodynamics

ASSESSMENT SYSTEM FOR THEORY:

Quizzes	10-15%
Assignments	5-10%
Mid Terms	30-40%
ESE	40-50%

ASSESSMENT SYSTEM FOR LAB:

Quizzes	10%-15%
Assignments	5% - 10%
Lab Work and Report	70-80%
Lab ESE/Viva	20-30%

Teaching Plan

Week No	Topics	Learning Outcomes
1	Introduction & Concepts Review	1. Course outline, objectives, teaching plan, and assessment method. 2. Revision of basic Thermodynamics and Heat

		Transfer concepts.
2	**Chapter 1** Introduction to Heat Transfer	1. Understanding different modes of Heat Transfer i.e. Conduction, Convection and Radiation. 2. Developing the sense of solving common engineering problem in heat transfer.
3-4	**Chapter 2** Heat Conduction Equation	1. Understanding the multidimensionality and time dependence of heat transfer. 2. Obtain the differential equation of heat conduction in various coordinate systems, and simplify it for steady one-dimensional case. 3. Identify the thermal conditions on surfaces, and express them mathematically as boundary and initial conditions. 4. Solve one-dimensional heat conduction problems and obtain the temperature distributions within a medium and the heat flux.
5-6	**Chapter 3** Steady Heat Conduction	1. Analyze steady heat conduction in plane walls. 2. Solving the problems using thermal resistance networks analogy concept. 3. Solve one-dimensional, steady conduction heat transfer problems in various geometries. 1. Heat transfer form finned surface. 2. Boundary conditions at fin tip. 3. Fin efficiency and fin effectiveness.
7	**Chapter 6** Fundamentals of Convection	1. Laminar and Turbulent Flows 2. Blasius solution for flat plat 3. Analogies between momentum & heat transfer.
9	**MID TERM EXAM**	
8 and 10	**Chapter 7** External Forced Convection	1. Distinguish between Internal & External flow. 2. Evaluate drag and heat transfer associated with flow over flat plat for Laminar & Turbulent flow. 3. Determine the Pressure drop & Heat transfer coefficient associated with flow across a tube bank for both In-line & Staggered configuration.
11-12	**Chapter 8** Internal Forced Convection	1. Mean Velocity and Mean Temperature 2. The Entrance Region 3. General Thermal Analysis
13- 14-15	**Chapter 9** Natural Convection	1. Physical Mechanism of natural convection 2. Equation of Motion and the Grashof Number 3. Natural Convection Over Surfaces
16-17	**Chapter 11** Heat Exchangers	1. Types of Heat Exchangers 2. The Overall Heat Transfer Coefficient 3. The LMTD Method 4. The Effectiveness–NTU Method
15, 16	**Chapter 11, 12** Fundamentals of Thermal Radiation	1. Introductory concepts 2. Blackbody radiations and Radiative properties 3. Radiation View/shape factors 4. Diffuse and Grey surfaces

		5. Net radiation heat transfer to or from a surface
16, 17	**Chapter 14** Mass Transfer	Analogy between heat and mass transfer Mass diffusion, Fick's law Simultaneous heat and mass transfer
18	**END SEMESTER EXAMS**	

Ser	Lab Equipment	List of Experiments
1		Lab Visit – Briefing on Lab Equipment and General Safety Precautions
2	Thermal Conductivity of Liquid & Gases Apparatus	**Experiments 1** To calculate the thermal conductivity of the material.
3-5	Heat Conduction Study Unit (Linear & Radial)	**Experiments 2** To investigate Fourier's Law for the linear conduction of heat along a homogenous bar. **Experiments 3** To investigate the effect of a change in the cross-sectional area on the temperature profile along a thermal conductor. **Experiments 4** To examine the temperature profile and determine the thermal conductivity of the material in case of radial conduction along a cylinder.
6	Radiation Heat Transfer Apparatus	**Experiments 5** To demonstrate the use of extended surface to improve heat transfer from the surface.
7-8	Free & Forced Convection Heat Transfer	**Experiments 6** To demonstrate the relationship between power input and surface temperature in free and forced convection. **Experiment 7:** To demonstrate the use of the extended surface to improve heat transfer from the surface
9-14	Multi Heat Exchanger Service Unit • Concentric Tube Heat Exchanger • Shell & Tube Type Heat Exchanger	**Experiments 8** Calculate the Heat Transfer by the hot fluid, the heat gain by the cold fluid and heat losses.
		Experiments 9 Calculate the global heat transfer co-efficient (U) for both inner and outer surface of the tubes.
		Experiments 10 Variation of hot and cold-water flow and record the temperature
		Experiments 11 Calculate the Heat Transfer by the hot fluid, the heat gain by the cold fluid and heat losses.
		Experiments 12 Calculate the heat transfer effectiveness of the heat exchanger.

		Experiments 13 To demonstrate that intensity of radiation varies as the fourth power the source temperature.
15	**Lab End Term**	