MEC3204: Heat Transfer

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
45	30		60	100	60	40	4

Course description

(2 Hours)

Heat Transfer is a fundamental topic for a mechanical engineering student. This course introduces the student to basic concepts of heat transfer. It covers conduction heat transfer, convection heat transfer, radiation heat transfer and Heat Exchangers. In convection heat transfer, both laminar and turbulent cases are handled

Course Objectives

- To provide an introductory treatment of the basic concepts of heat transfer
- To develop the analytical and critical thinking abilities fundamental to problem solving in heat transfer.
- To provide the students with real everyday applications of situations characteristic of the heat transfer problem

Learning Outcomes

At the end of this course the student should be able to:

- Describe the basic concepts and laws of heat transfer both qualitatively and quantitatively.
- Demonstrate analytical knowledge in the quantification of the different modes of heat transfer
- Compute the amounts of heat transferred between different media in a heat exchanger system

Course Content

Basic concepts and laws of heat transfer analysis **(4 Hours)**

- Conduction Heat Transfer
- Thermal Conductivity
- Convection Heat Transfer

- Radiation Heat Transfer

Steady-State Conduction - One Dimension **(8 Hours)**

- The Plane Wall
- Insulation and R values
- Radial Systems
- The Overall Heat-Transfer Coefficient
- Critical Thickness of Insulation
- Heat-Source Systems
- Cylinder with Heat Source
- Conduction-Convection Systems
- Fins
- Thermal Contact Resistance

Principles of Convection **(8 Hours)**

- Viscous Flow and Inviscid Flow
- Laminar Boundary Layer on a Flat Plate
- Energy Equation of the Boundary Layer
- The Thermal Boundary Layer
- The Relation between Fluid Friction and Heat Transfer
- Turbulent-Boundary layer Heat Transfer
- Heat Transfer in Laminar Tube Flow
- Turbulent Flow in a Tube

Empirical and Practical Relations for Forced-Convection

Heat Transfer **(4 Hours)**

- Empirical Relations for Pipe and Tube Flow
- Flow across Cylinders and Spheres
- Flow across Tube Banks

Natural Convection Heat Transfer **(6 Hours)**

Physical Considerations and the Governing Equations Laminar Free Convection on a Vertical Surface The Effects of Turbulence External Free Convection Flows Free Convection within Parallel Plate Channels Empirical Correlations Combined Free and Forced Convection ***Condensation and Boiling Heat Transfer*** **(5 Hours)**

Dimensionless Parameters in Boiling and Condensation Boiling Modes

Pool Boiling and pool boiling correlations Forced-Convection Boiling Condensation: Physical Mechanism Laminar Film Condensation on a Vertical Plate Turbulent Film Condensation

Film Condensation on Radial Systems and in horizontal tubes Dropwise Condensation ***Heat Exchangers*** **(4 Hours)**

Heat Exchanger Types Use of Log Mean Temperature Difference The Effectiveness-NTU Method Methodology of a Heat Exchanger Calculation Compact Heat Exchangers ***Radiation Heat Transfer*** **(6 Hours)**

Fundamental Concepts Radiation Intensity Blackbody Radiation Surface Emission

Surface Absorptivity, Reflection, and Transmission Kirchhoffs Law The Gray Surface The Geometric View Factor

Radiation Exchange between Diffuse, Gray Surfaces in an Enclosure ***Practicals*** **(45 Hours)**

Delivery Methods:

The course will be taught by using lectures and tutorials and laboratories ***Assessment Methods:***

Course work (assignments and tests) and final examination and their relative contributions to final grade are shown as follows:

Requirement ***Percentage contribution***

Course work 40%

Final examination 60%

Total 100%

Recommended and Reference Books

F. P. Incropera, D. P. DeWitt, Fundamentals of heat and mass transfer, Wiley, 2002

F. P. Incropera, Introduction to heat transfer, Wiley, 2007

J. P. Holman, Heat Transfer, McGraw-Hill, 2002.

J. H. Lienhard, A heat transfer textbook, Dover Publications, 2011.

Y. A. Cengal, Heat transfer: a practical approach, McGraw-Hill, 1998

T. Muneer, J. Kubie, T. Grassie, Heat Transfer: a problem solving approach, Taylor &

Francis, 2003

S. Bhattacharyya, Heat transfer in SI units, McGraw-Hill, 2008

W. M. Rohsenow, J. P. Hartnett, Y. I. Cho, Handbook of heat transfer, McGraw-Hill, 1998

W. S. Janna, Engineering Heat Transfer, CRC Press, 2000.