McEng 3242 – Heat Transfer

Course Number: McEng 3242 **Course Title:** Heat Transfer	**Credit Hours:** 3 **Contact Hours**: 2 Lecture hrs and 3 Tutorial hrs

Course Objectives:

At the end of this course, students will be:

- Equipped with the basic principles required for understanding conduction, radiation and convection heat transfer.
- Able to apply the basic principles of heat transfer in the analysis and design of engineering systems.

Course Description:

Steady heat conduction: One and two dimensional applications; Analytical and numerical solutions; One dimensional transient heat conduction: Analytical, numerical and graphical solutions; Convective heat transfer: Forced and natural with laminar and turbulent flows; Boiling and condensation heat transfer coefficients; Dimensionless parameters; Radiation: Basic definitions; Black body radiation; Radiation of technical surfaces in the presence of absorbing and emitting gases; Heat exchangers: parallel, counter and cross flow.

Course Outline:

1. **Introduction**: Definition of heat transfer, Modes of heat transfer: conduction, convection, radiation; Combined modes of heat transfer; Analogy between heat transfer and flow of electric current; The overall heat transfer coefficient
2. **One Dimensional Steady-State Conduction:** Physical mechanism of conduction; General heat conduction equation in: rectangular -, cylindrical - and spherical co-ordinate systems; Plane wall with specified boundary temperature; Multi-layer wall with specified boundary temperature; Conduction with uniformly heat generation; Effect of variable thermal conductivity; Critical thickness of insulation; Heat transfer from extended surfaces.
3. **Two Dimensional Steady State Heat Transfer:** Analytical method (the method of separation of variable); Numerical method (the finite difference method); Graphical

method.

4. **Transient Heat Conduction:** The lamped capacitance method; Validity of lumped capacitance method; One-dimensional system with convective surface conditions (application of Heisler and Grober Charts); Graphical method - Schmidt Plot.
5. **Introduction to convection:** The convection transfer equation; Convection boundary layers: Velocity boundary layer and thermal boundary layer; Significance of boundary layer; Laminar and turbulent flow
6. **Forced Convection:** Methodology for convection calculation of flat plate in parallel flow with laminar; Mixed and turbulent flow conditions; The cylinder in cross flow; The sphere; Flow across bank of tubes; Internal flow; The mean velocity; Velocity profile in fully developed region; The mean temperature; Convection correlation laminar flow in circular tubes for fully developed and entry regions; Convective correlation for turbulent flow in circular tubes; Convection correlation for non-circular tubes.
7. **Free Convection:** Physical considerations; The governing equation; Free convection on a vertical plate; Empirical correlations for external flows of vertical- plate, inclined and horizontal plates.
8. **Heat Transfer with phase change:**
9. **Heat Exchangers:** Heat exchanger types; The overall heat transfer coefficient; Heat exchanger analysis using lo mean temperature difference and the effectiveness-NTU method; Method of heat exchanger calculation
10. **Radiation Heat Transfer:** Blackbody radiation exchange; Radiation exchange at surface; The view factor; View factor relations; Radiation exchange between surfaces.

Pre-requisites: McEng 2102, Applied Thermodynamics

Co-requisite:

Textbook: Incropera F., and David P, Dewitt, *Introduction to heat Transfer*

References:

1. Holman J P, ***Heat Transfer***, McGraw Hill Int.
2. Dewitt I., *Fundamentals of Heat transfer*
3. Chapman A.J., *Heat Transfer*
4. Eckert E.R.G. and R.M. Drake, *Heat Transfer*
5. Gupta C.P.**,** ***Engineering Heat Transfer***

6. Oezisisk M.N, *Basic Heat Transfer*

Teaching Methods:

- Lectures supported by tutorials, and
- Assignments.

Laboratory exercises:

1. Experiment on determination of thermal conductivity of a solid
2. Double Pipe Heat Exchanger Experiment

Attendance Requirement:

- Minimum of 75% attendance during lecture hours; and
- 100% attendance during practical work sessions, except for some unprecedented mishaps.

Evaluation:

Continuous Evaluation systems 50%

Final exam 50%

Hours per-semester: 80