MEC 502: Conduction and Radiation Heat Transfer

Spring 2021

Class hours: Monday 12:30 am to 3:20 pm

Course Description: Heat conduction and conservation laws; formulation of conduction equations in differential and integral forms; analytical solution techniques including Laplace transforms and separation of variables; scaling analysis; blackbody radiation, Kirchoff's law, analysis of heat conduction problems; analysis of radiative exchange between surfaces and radiative transport through absorbing, emitting, and scattering media.

Learning Objectives: To understand the fundamental mechanism of conduction and radiation heat exchanges; based on the thermodynamic laws to consider heat conduction in solids and the radiative heat transfer between solid surfaces, and in absorbing, emitting, scattering media; To acquire the ability of estimating the heat transfer rates by applying the formulas to various geometries of engineering interest.

Prerequisites: None

Textbooks:

Foundations of Heat Transfer by F.P Incropera, D.P. Dewitt, T.L. Bergman, and A.S. Lavine, 6th edition (John Wiley & Sons, 2013)

Thermal Radiation Heat Transfer, J.R. Howell, M.P. Mengüç, K. Daun, and R. Siegel, 7th edition (CRC Press, 2020)

Reference: Conduction of Heat in Solids, H.S. Carslaw and J.C. Jaeger, 2nd edition (Oxford Science Press, 1959)

Course Topics:

1. Introduction: Overview of conduction, radiation and convection
2. Fundamental principles: Conservation laws
3. One-dimensional steady-state conduction
4. Multi-dimensional steady-state conduction: Sturm-Liouville theory, Separation of variables
5. Transient conduction: Similarity solution, Laplace transform
6. Fundamentals for surface radiation, and radiation in participating media
7. Surface radiation properties of electric and die-electric materials
8. Configuration factors between differential and finite surfaces
9. Surface radiation exchange in enclosures
10. Fundamental mechanisms of absorbing, emitting, and scattering
11. Radiative transfer equation (RTE)
12. Radiative transfer in a planar medium
13. Solution methods: Optical thickness, differential approximations

Grades:

Attendance	10 points
Homework	20 points
Midterm exam.	30 points
Final Exam.	40 points