

MAE 310: Heat Transfer Fundamentals

TENTATIVE COURSE TOPICS

Reference: F. P. Incropera and D. P. Dewitt, *Fundamentals of Heat and Mass Transfer*, John Wiley and Sons, 5th Edition, 2001.

- 0. Introduction to Heat Transfer {Chapter 1}
 - Introduction to conductive heat transfer
 - Introduction to radiative heat transfer
 - Introduction to convective heat transfer
 - Coupled modes of heat transfer

- I. Conductive Heat Transfer
 - Conservation of energy
 - Fourier's law
 - Newton's law of cooling
 - Boundary and initial conditions
 - Steady one-dimensional conduction
 - ✦ Planar systems
 - ✦ Radial (cylindrical and spherical) systems
 - ✦ Contact resistance
 - ✦ Variable conductivity
 - ✦ Critical radius
 - ✦ Planar and radial systems with energy generation
 - Extended surfaces (fins)
 - ✦ Governing equations
 - ✦ Specific boundary conditions and solutions
 - ✦ Fin efficiency and effectiveness
 - ✦ Finned wall systems
 - General conduction equation
 - Steady two-dimensional solutions
 - ✦ Separation of variables
 - ✦ Superposition
 - ✦ Conduction shape factors
 - Unsteady heat conduction
 - ✦ Biot and Fourier numbers
 - ✦ Lumped heat capacity analysis
 - ✦ General unsteady multi-dimensional analysis
 - Numerical methods for conduction
 - ✦ Unsteady equations and stability criteria
 - ✦ Explicit and implicit methods
 - ✦ Steady state methods

II. Radiative Heat Transfer

- Basic definitions
 - ✦ Blackbody emission
 - ✦ Total properties
 - ✦ Kirchoff's law for gray bodies
- Radiative view factors
 - ✦ General definition
 - ✦ View factor integral
 - ✦ Reciprocity and enclosure relations
 - ✦ Crossed-string method
 - ✦ Tables and figures
- Black surface exchange
- Gray, diffuse surface exchange
 - ✦ Radiosity
 - ✦ General coupled equations
 - ✦ Electrical analogy

III. Convective Heat Transfer

- Forced convection
 - ✦ Velocity and thermal boundary layers
 - ✦ Governing equations (mass, momentum and energy)
 - ✦ Solutions to forced convection: Poiseuille flow, Couette flow
 - ✦ Non-dimensional forms of governing equations
 - ✦ External flows
 - Flat plate boundary layer solutions and correlations
 - Boundary layer similarity and Reynold's analogy
 - Correlations for internal flows
 - ✦ Internal flows
 - Tube flow analysis and solutions
 - Correlations for internal flows
- Natural convection
 - ✦ Velocity and thermal boundary layers
 - ✦ Governing equations (mass, momentum and energy)
 - ✦ Non-dimensional forms of governing equations
 - ✦ Correlations for internal and external flows
- Mixed convection
 - ✦ Governing equations (mass, momentum and energy)
 - ✦ Non-dimensional forms of governing equations
 - ✦ Application of correlations for internal and external flows