# ME303 Heat Transfer

Credit: 3 Approval: Approved in 3rd Senate

Prerequisite: Fluid Mechanics, Thermodynamics

Students intended for:

Elective or Core: Core Semester: Odd/Even

**Course objective:**

To impart basic knowledge of heat and mass transfer mechanisms

**Course Contents:**

- **Introduction:** Modes of heat transfer, examples, difference between thermodynamics and heat transfer, fundamental laws, Fourier's law of heat conduction, thermal conductivity, Newton's law of cooling, Stefan – Boltzmann's law, combined modes of heat transfer.
- **Heat Conduction:** 1 – D conduction: General heat diffusion equation derivations, 1 – D steady state heat conduction equation for a slab, composite slab, Boundary conditions, Thermal resistance concepts, electrical analogy, overall heat transfer coefficient, 1 – D heat conduction equation in cylindrical and spherical coordinates, composite cylinders and spheres, Critical thickness of insulation, heat generation inside slabs and radial systems
- Fins: heat transfer from extended surfaces, fin performance
- Multi-dimensional heat conduction: 2D steady state heat conduction, analytical solution
- Unsteady conduction: introduction, lumped capacitance model, derivation and solution of lumped capacitance model, validity, Biot and Fourier Numbers,transient heat conduction in infinite and semi-infinite slabs, Heisler charts.
- Numerical Methods: Numerical methods for heat conduction, solution techniques-Matrix inversion, Gauss Seidal iteration technique
- **Convection Heat Transfer:** Forced convection: Derivation of energy equation
- External Flow: Flow over flat plate, concept of Hydrodynamic Boundary Layer, Thermal Boundary Layer, derivation of boundary layer equations, physical significance of dimensionless numbers, cylinder in cross flow, Flow over bank of tubes
- Internal flows: Laminar flow through duct, concept of Hydrodynamic boundary layer, entry length, mean velocity, mean temperature, fully developed conditions for constant temperature and constant heat flux, turbulent flow in pipes.
- Free convection: Natural convection: concepts, boundary layer, equations of motion, energy, convection over different configurations.
- Condensation and Boiling: Introduction to boiling and condensation, dimensionless parameters in condensation, regimes of boiling heat transfer, condensation over vertical surfaces, velocity and temperature profiles, film condensation of radial systems, Laminar film condensation over a vertical plate and horizontal circular tube
- **Heat exchangers:** Classification of heat exchangers, overall heat transfer coefficient, concept of fouling factor, LMTD and NTU methods of analysis for a heat exchanger, applications to multi-tube, multi-pass heat exchangers.
- **Thermal radiation:** Radiation properties, blackbody radiation, Planck's law, Stefan-Boltzman law, Kirchoff's law, radiation exchange between black surfaces, concept of view factor, radiation exchange between non-black surfaces, two-surface enclosure, three surface enclosure, concept of radiation shield.
- **Introduction to Mass Transfer:** Mass diffustion, Ficks Law, Heat and Mass Transfer analogy

**Suggested Books**:

Fundamentals of Heat and Mass Transfer, Incropera and Dewitt, Wiley India

Heat and Mass Transfer, Cengel, TMH

Additional Reading:

Principles of Heat Transfer, Krieth and Bohn, Cengage Learning

Heat Transfer, Holman, TMH

A heat Transfer Text Book, Lienhard IV and Lienhard V, Dover Publishers

http://web.mit.edu/lienhard/www/ahtt.html