Convective Heat and Mass Transfer - Web course

COURSE OUTLINE

Introduction ; Basic Equations: Reynolds Transport Theorem; Compressible and Incompressible Flows

Derivation of Energy Equation using specific coordinate system; Preliminaries on the Tensor Analysis ; Derivation of Energy Equation (using Generalized Approach)

Important Dimensionless Numbers; Concepts of velocity boundary layer and thermal boundary layer, displacement thickness, momentum thickness and energy thickness.

Derivation of velocity boundary layer and thermal boundary layer equations.

External Flows: Flow over a Flat Plate; Blasius Solution, Temperature distribution over a flat plate boundary layer (derivation of the ordinary differential equations from the partial differential equations)

Numerical Solution (shooting technique); Analytical Solution (Series Solution, principles of similarity and the similarity solution of velocity boundary layer.

Approximate Method (Karman-Pohlhausen Method) for flow over a heated flat plate. Solution of Momentum Integral equations (including the cases of suction and blowing). Solution of Energy Integral equation for the case of Pr>1. Effect of pressure gradient on heat transfer in Integral solutions.

Viscous dissipation effects on Boundary Layer Flow over a Heated Flat Plate. Influence of Prandtl number and Eckert number.

Solution of Falkner-Skan Equation for flow and heat transfer over non-zero pressure gradient surface.

Analysis of Heat Transfer and Flow over a Circular Cylinder.

Internal Flows: Fully developed flows through pipes and ducts (analytical solution).

Thermal considerations; Physical significance of Prandtl number. Flow of low Prandtl number fluids.

Thermally fully developed conditions (for uniform wall heat flux

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Mechanical Engineering

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and uniform wall temperature cases); Heat transfer through a circular tube for hydrodynamically developed and thermally developed flow with uniform wall heat flux boundary condition

Heat transfer through a circular tube for hydrodynamically developed and thermally developed flow with uniform wall temperature boundary condition.

Graetz Problem: Heat transfer through a circular tube for hydrodynamically developed and thermally developing flow with uniform wall heat flux boundary condition.

Numerical Solution of Navier-Stokes and Energy Equations for 3-D Incompressible Flows through a rectangular duct (to be continued)

Turbulent Flow and Heat Transfer: Classical Idealization of Turbulent Flows, Concept Eddy Viscosity and Eddy Diffusivity

Turbulent Boundary Layer; Universal velocity Profile; Laws of Wall

Turbulent Flow and Heat transfer through a pipe; Chilton-Colburn Analogy, Reynolds' Analogy; Convection Correlations

Computational Approaches for solving turbulent flows and k-epsilon model of turbulence.

Free Convection: Analytical solution for flow over a heated vertical plate.

Free Convective Flows for other important geometries; Mixed Convection; Influence of Richardson number, Archimedes number.

Condensation; Transpiration cooling.

Boiling; Nucleation and Bubble Growth; Homogeneous Nucleation; Heterogeneous Nucleation; Bubble Growth Without Heat and Mass Transfer

Convective Mass Transfer; The Concentration boundary layer; Heat and Mass Transfer Analogy