THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

Intermediate Numerical Methods

MECHENG 6507

Credit Hours:
3.00 - 3.00

Course Levels:
Graduate (5000-8000 level)

Course Components:
Lecture

Course Description:
Numerical techniques and computer algorithms to solve initial and boundary value problems relevant to engineering applications, such as heat conduction and mass diffusion.

Prerequisites and Co-requisites:
Prereq: 2850, Math 2174, 2415, or 4512; or Grad standing in MechEng or AeroEng, or NuclrEng; or permission of instructor.

Course Goals / Objectives:
- Apply finite-difference methods to solution of elliptic, parabolic, and hyperbolic partial differential equations
- Apply finite-volume methods to solution of elliptic, parabolic, and hyperbolic partial differential equations
- Solve set of linear algebraic equations resulting from discretization of partial differential equations using various direct and iterative solution methods
- Calculate, analyze, and reduce errors in numerical solution

Course Topics:

- Classification of PDEs, general discussion of methods for solving PDEs, types of meshes used etc.
- Derivation of finite-difference equations, errors in difference approximations, application of boundary conditions
- Direct Solution Techniques: tri-diagonal matrix (TDMA) inversion, LU decomposition, Gaussian elimination, incomplete LU decomposition, basics of pre-conditioning
- Treatment of non-linearity, Newton’s method for simultaneous non-linear equations
- Iterative solution techniques: Jacobi, Gauss-Seidel, Line-by-line (ADI), Stone’s method, conjugate gradient (CG).
- Convergence analysis, spectral radius of convergence, Fourier analysis of errors
- Multi-grid methods: basic philosophy and simple two-stage geometric multi-grid solution
- Higher-order methods (in space), improvement in accuracy
- Parabolic problems: treatment of time derivative, Euler and Crank-Nicolson, time marching methods
- Irregular geometries: coordinate transformation, cylindrical coordinates
- Finite-Volume method: basic philosophy and fundamental differences with finite-difference method
- Finite-Volume discretization on unstructured mesh
- Introduction to the Navier-Stokes equation
- Hyperbolic wave equation, Euler and Burger’s equations, schemes for hyperbolic equations

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Designation:

Elective