CE/AME/ACMS 60130 FINITE ELEMENTS IN ENGINEERING

COURSE OUTLINE

SPRING 2018

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Room 156 Fitzpatrick Hall
Office hours: Monday, Wednesday 2:00pm-3:00pm

Course Material: Lectures will be based on a set of class notes available at:
https://coast.nd.edu/jjwteach/www/www/60130/notes.html

The recommended course reference:
Celia, M.A. and W.G. Gray, Numerical Methods for Differential Equations, Prentice Hall, Englewood Cliffs, 1991.

Furthermore, supplemental notes which discuss basic topics in numerical analysis (solving systems of simultaneous equations, interpolation, root solving, finite difference approximations, numerical integration and introduction to o.d.e.'s and p.d.e.'s) are available on the web at:
https://coast.nd.edu/jjwteach/www/www/index_30125.html

Grading:

Test 1	25%
Test 2	25%
Homework	20%
Final Project	30%

Topics

- The method of weighted residuals
  - admissibility, norms, orthogonality and completeness
  - collocation
  - least squares
  - Galerkin
  - subdomain, method of moments, least squares collocation
- Symmetry and other properties of matrices and operators
  - symmetry and self adjointness
  - positive definite matrices and operators
  - derivation of boundary conditions associated with an operator

- Weak formulations
  - Sobelov space
  - fundamental weak form
  - symmetrical weak form
  - use of localized functions
  - weak forms in 2D
  - time dependent problems
- The Finite Element Method
  - general steps
  - derivation of 1-D C° Lagrange elements
  - derivation of 1-D C′ Hermite elements
  - applications using cardinal and localized basis functions
  - numerical quadrature
  - time discretization
  - lumping

- Solution of the convection-diffusion equation using FEM
  - standard Galerkin
  - control of spurious oscillation
  - Petrov-Galerkin solutions
  - higher order Petrov-Galerkin solutions
  - truncation error analysis and Fourier analysis

- FE method for 2D problems
  - derivation of interpolating basis for quadrilateral elements
  - derivation of interpolating basis for triangular elements
  - example applications

- Solution to the Transient 1D diffusion Equation
  - explicit methods
  - implicit methods

- Accuracy and Stability Analysis
  - truncation error analysis
  - heuristic stability analysis
  - stability analysis by von Neumann’s method

- Improved accuracy through temporal and spatial refinement
  - uniform refinement
  - selective refinement
  - mesh optimization
  - dynamic gridding