ACMS 40790 Topics in Applied Mathematics
Numerical Methods for Partial Differential Equations

Textbook: G. Evans, J. Blackledge, and P. Yardley, Numerical Methods for Partial Differential Equations, Springer, 2000. ISBN: 3-540-76125-X.

Pre-requisite: Scientific Computing (ACMS 20210), Applied Math Methods II (ACMS 20750). Numerical Analysis (ACMS 40390) is preferred, but not required.

Course description: The course will cover numerical algorithms which are useful for solving partial differential equation problems in science and engineering. Algorithm design, analysis and computer implementation will be discussed.

Topics to be covered:

1. Finite Differences and Parabolic Equations
   - Finite difference approximations to derivatives
   - Parabolic equations
   - Local truncation error, consistency, convergence, stability
   - The Crank-Nicolson implicit method
   - Parabolic equations in cylindrical and spherical polar coodinates

2. Hyperbolic Equations and Characteristics
   - First order quasi-linear equations
   - Lax-Wendroff methods
   - Second order hyperbolic equations and numerical methods

3. Elliptic Equations
   - Laplace's equation
   - Curved boundaries
   - Solution of sparse linear systems

4. Finite Element Method for Ordinary Differential Equations
   - The collocation method
   - The Galerkin method
   - Symmetric variational formulation
   - Finite element method

5. Finite Element Method for Partial Differential Equations
   - Variational methods
   - Some specific elements
   - Assembly of the elements
   - A general variational principle
   - Assembly and solution
   - Quadrature methods and storage considerations