ENGM6658

Numerical Solutions of Differential Equations

Textbook

G.D. Smith: Numerical Solution of Partial Differential Equations – Finite difference methods.

Summary

Mathematical models are used in engineering to understand physical systems and make predictions. They are important in all aspects of engineering design, optimization subject to constraints, and risk assessment. Their solutions are typically approximated for simple geometries using finite difference methods. These methods are analyzed for consistency, stability, and convergence, and applied to parabolic, elliptic, and hyperbolic classes of partial differential equations. Matrix and iterative schemes are examined along with linearization for the solution of mildly nonlinear models. Experience is gained in mathematical modelling, scaling analysis, and presentation of results.

List of Topics

1. Overview of introductory numerical solution methods and background of finite difference methods
2. General description of parabolic, elliptic, hyperbolic, and hybrid models (convective-diffusion)
3. Boundary and initial conditions in partial differential equations in finite, semi-infinite, and infinite domains
4. Consistency, stability, and convergence of finite difference methods for partial differential equations
5. Mathematical model rescaling where useful to enable, describe, and facilitate numerical solution of mathematical models and presentation of results.

Assessment

Three assignments. One project with class presentation. Two lectures per week.