University of Waterloo Department of Applied Mathematics

AMATH 741 / CS 778
Numerical Solution of Partial Differential Equations
Winter 2007

Many problems in science, engineering, finance and economics can be formulated in terms of partial differential equations (PDEs). Since analytical solutions are not available in general, it is necessary to use numerical methods to approach the solution. This course will cover the basic techniques for solving PDEs numerically. The goal of the course is threefold. You will receive a solid introduction to the theory of numerical methods for partial differential equations (with derivations of the methods and some proofs). You will learn to implement the computational methods efficiently in Matlab, and you will apply the methods to problems in several fields, for example, fluid mechanics, diffusion processes and wave phenomena. You will also apply the course material to a problem in your own field of research in a project. Some previous experience with numerical computation (e.g. CM 271/AMATH 341/CS 370 or CS 371) and MATLAB, and some background in PDEs, is desirable.

Outline:

- classification of PDEs
- Finite Difference methods
- Finite Volume methods for conservation laws
- Finite Element methods
- implicit schemes and iterative solvers
- Spectral methods

References:

1. "Numerical Partial Differential Equations: Finite Difference Methods", by J.W. Thomas, Springer, 1995.
2. "Finite Volume Methods for Hyperbolic Problems", by Randall J. LeVeque, Cambridge University Press, 2002.
3. "Finite Elements: Theory, Fast Solvers, and Applications in Solid Mechanics", by Dietrich Braess, Cambridge University Press, 2001.
4. "An Introduction to the Finite Element Method", by J.N. Reddy, McGraw-Hill, 1993.

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Lecture times: 2:30 p.m. - 3:50 p.m. on Wednesday & Friday in RCH 309

First lecture: Wednesday, January 10, 2007 at 2:30 - 3:50 p.m. in RCH 309.