Review for Midterm

The midterm will be on Friday, May 15 — Closed book exam and you will not need a calculator.

The midterm will cover numerical methods for ordinary differential equations (initial value problem), linear parabolic PDEs, the advection equation, and general concepts that might apply to other PDEs.

Note that there are additional exercises available on the book webpage.

Some of the things you might want to review:

- Chapters 5–9 and Sections 10.1–10.6.
- Definition of local truncation error (LTE), how to compute it for a given method.
- Consistency, order of accuracy.
- LTE vs. one-step error vs. global error.
- Derivation of a method of a given form with specified order — finding the coefficients.
- In particular, derivation of Adams methods and BDF methods. Taylor series methods.
- Lipschitz continuity and determining L.
- Convergence proof for Euler's method and general 1-step ODE methods.
- Solution of linear difference equations, characteristic polynomials.
- Zero-stability — what it means, how to determine for LMMs.
- Region of absolute stability, linear test equation.
- Idea of the boundary locus method for plotting stability regions.
- Estimating the step size needed for accuracy, stability on a given ODE.
- Stiffness — what is it? What sort of methods are needed?
- Implicit vs. explicit methods, LMM's vs. Runge-Kutta methods — advantages or disadvantages of each.
- Basic methods such as forward and backward Euler, trapezoidal, leapfrog. You don't need to memorize higher order multistep or Runge-Kutta methods!
- Basic methods for diffusion, particularly Crank-Nicolson, stiffness of parabolic equations and stability requirements.
- Basic methods for advection equations: Upwind, Lax-Friedrichs, Leapfrog, Lax-Wendroff.
- Method of lines (MOL) approach to discretizing a PDE.
- Setting up a system of equations and boundary conditions for such a discretization.
- Applying ODE stability theory to MOL discretization.
- Lax-Richtmyer stability, relation between ODE and PDE stability concepts.
- von Neumann analysis of stability and Fourier analysis of PDEs.