April 8, 2009

Numerical Differential Equations Syllabus

Ordinary differential equations

Lipschtz condition; Euler's methods, trapezoidal rule, theta method

Linear multistep methods; Adam methods; order and convergence of multistep methods; backward differentiation formulae

Runge-Kutta methods: explicit and implicit schemes

Stiff equations: linear stability domain and A-stability; A-stability of linear multistep methods and Runge-Kutta methods

Local error, global error and error control

Partial Differential Equations

Poisson's equation: finite difference scheme, five point stencil for laplacian; conversion to matrix equation;

Diffusion equation: method of lines, stability, stiffness and convergence. ODE vs PDE convergence. von Neumann analysis

Advection equations and hyperbolic systems: forward Euler time discretization, leapfrog, Lax-Friedrichs, Lax-Wendroff; upwind methods; von Neumann analysis. Characteristic. CFL condition.

References:

R. J. LeVeque: Finite Difference Methods for Ordinary and Partial Differential Equations, SIAM, 2007

A. Iserles: A First Course in the Numerical Analysis of Differential Equations, Cambridge University Press, 1996.

L. N. Trefethen: Finite Difference and Spectral Methods for Ordinary and Partial Differential Equations(available on line at url http://www.comlab.ox.ac.uk/nick.trefethen/pdetext.html)