Math 572 - Winter 2005
Numerical Methods for Scientific Computing II
Differential Equations

Time. Tues/Thurs 10-11:30am, 130 Dennison

Instructor. Robert Krasny, 4830 East Hall, 763-3505, krasny@umich.edu

Office Hours. Tues/Thurs 11:30-12:30pm and by appointment or just drop in

Course Website. http://www.math.lsa.umich.edu/~krasny/math572.html

Description. Computer simulation is pervasive in modern scientific research; it is routinely used in engineering and science, and increasingly in other fields as well such as finance and medicine. However, computer simulations can be challenging - using a faster computer is no guarantee of success and sometimes one must use a smarter method. Math 572 is an introduction to numerical methods used in solving differential equations. The course will focus on finite-difference schemes for initial value problems for ordinary and partial differential equations. Theoretical concepts and practical computing issues will be covered.

Prerequisites.
advanced calculus, linear algebra, complex variables. Math 571 is not a prerequisite.

Texts.
"Computer Methods for Ordinary Differential Equations and Differential-Algebraic Equations", by U.M. Ascher and L.R. Petzold, SIAM

"Numerical Solution of Partial Differential Equations", by K.W. Morton and D.F. Mayers, Cambridge University Press

These are recommended texts. I'll be using my own lecture notes, but these texts are good for supplementary reading.

Syllabus.
ODEs: Euler's method, asymptotic expansion of the error, Richardson extrapolation, Taylor series method, Runge-Kutta method, multistep methods, leap-frog method, consistency, stability, convergence, root condition, absolute stability, stiff systems, A-stability

PDEs: heat equation, wave equation, finite-difference schemes, artificial viscosity, Crank-Nicolson method, Lax-Wendroff method, operator splitting, ADI, stability analysis, maximum principle, energy method, discrete Fourier analysis, CFL condition, Lax equivalence theorem, Kriess matrix theorem, pseudospectral method, trigonometric interpolation, Gibbs phenomenon, hyperbolic conservation laws

Course Grade. The course grade will be based on homework (30%), a midterm exam (30%), and a final exam (40%). The homework you submit should be neat and legible; if it isn't, points will be deducted. The homework will include programming exercises for which I recommend using Matlab.

Final Exam. Wednesday, April 27, 4-6pm