Math 572 Numerical Methods for Differential Equations Winter 2025

Time: Tues/Thurs at 11:30am-1pm in 4096 East Hall

Instructor: Robert Krasny, 4830 East Hall, (734) 623-3962, krasny@umich.edu
office hours: Tues/Wed/Thurs 5-6pm, or just drop in, or email me for an appointment

GSI: Saem Han, saem@umich.edu, office hours: Math Atrium upper level, Monday 5-6pm

Course Website: click here

Description

Computer simulation is routinely used in science and engineering, and increasingly also in other fields such as finance and medicine. However, accurate and efficient computer simulations can be challenging; using a faster computer is no guarantee of success; sometimes a better algorithm is needed. Math 572 is an introduction to numerical methods for solving differential equations. The course focuses on finite-difference schemes for initial value problems involving ordinary and partial differential equations. Theory and practical computing issues will be covered.

Prerequisites

some knowledge of the following is assumed: advanced calculus, linear algebra, complex variables, Fourier series, ODEs and PDEs; Math 571 is not a prerequisite

Alternatives

Math 471 is an introductory survey of numerical methods covering topics such as root-finding, linear systems, eigenvalues and eigenvectors of matrices, polynomial interpolation, numerical integration, basic methods for ODEs and PDEs.

Math 571 is a graduate level introduction to numerical linear algebra sometimes including finite difference methods for two-point boundary value problems and the Dirichlet problem for the Laplace equation on a square.

Textbook

There is no required textbook; lecture notes will be posted on the course website, but the following text is recommended for outside reading.

R.J. LeVeque, Finite Difference Methods for Ordinary and Partial Differential Equations, (2007) SIAM, for a free PDF click here, for Professor LeVeque's website for the book click here

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 : homework = 30%, midterm exam = 30%, final exam = 40%

Exams : midterm, Thursday, February 27, time: tba, room: tba
final, Thursday, April 24, 4-6pm, room tba

Homework will be assigned every 1-2 weeks and should be scanned and uploaded into Canvas by the due date. Students may talk to each other about the homework problems, but each student should write up and submit their own solutions. The homework will include programming exercises for which you may use any language, e.g. Matlab, Python.