MATH 2090 NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS

FALL 2024

Instructor: Catalin Trenchea, Thackeray 612,
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Office hours: MWF 3:00-4:00 and by appointment.

Lecture: MWF 11:00-11:50AM, 627 Thackeray Hall.

Class web page: www.pitt.edu/~trenchea/Math2090_Fall_Semester_2024.html

Textbook: *Numerical Methods for Ordinary Differential Equations: Initial Value Problems*, by David F. Griffiths and Desmond J. Higham.

Prerequisites: Good undergraduate background in linear algebra and ordinary differential equations.

Content: This course is an introduction to modern methods for the numerical solution of initial and boundary value problems for systems of ordinary differential equations, stochastic differential equations, and differential algebraic equations. We will discuss the principal classes of numerical methods and of their theory, including convergence and stability considerations, consistency order, step size selection and adaptivity, the effects of stiffness, geometric integration, invariant and Hamiltonian dynamics.

Topics to be covered:

- Euler's method and Taylor series method
- Linear multistep methods: consistency, construction, zero-stability, absolute stability, root locus curve, stiff and oscillatory systems, predictor corrector methods
- Runge-Kutta methods
- Adaptive step size selection
- Long-term dynamics
- Geometric integration: linear and quadratic invariants, symplectic methods, Hamiltonian systems
- Stochastic differential equations, convergence of a numerical method

Homework: Written homework and several computational projects will be assigned.

Exams: There will be one in-class midterm exam, a paper presentation, and a final computational project.

Grading Policy: Midterm - 25%, final project - 20%, presentation - 15%, homework and computer assignments - 40% of the final grade.

Additional references:

- 'Solving Ordinary Differential Equations I, Nonstiff Problems', by Ernst Hairer, Syvert P. Nørsett, Gerhard Wanner. Springer.
- 'Solving Ordinary Differential Equations II, Stiff and Differential-Algebraic Problems', by Ernst Hairer, Gerhard Wanner. Springer.
- 'Geometric Numerical Integration Structure-Preserving Algorithms for Ordinary Differential Equations', by Ernst Hairer, Christian Lubich, Gerhard Wanner. Springer.
- 'Numerical Methods for Ordinary Differential Equations', Second Edition, by J. C. Butcher. John Wiley & Sons.
- 'Numerical Methods for Ordinary Differential Equations: The Initial Value Problem', by J. D. Lambert. John Wiley & Sons.
- 'Numerical analysis. An introduction', by Walter Gautschi. Birkhäuser.
- 'Computer Methods for Ordinary Differential Equations and Differential-Algebraic Equations', by Uri M. Ascher and Linda R. Petzold. SIAM.

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services, 216 William Pitt Union, (412) 648-7890/(412) 383-7355 (TTY), as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.