Math 4510/6510 Syllabus

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11:00-12:15 TR
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"Courses", "Math 4510"

Office hours: **(to be announced)**

Books: W. Cheney and D. Kincaid, *Numerical Mathematics and Computing* (7th edition), J. Demmel, *Applied Numerical Linear Algebra*.

Part I: Numerical Solution of ODE. Cheney/Kincaid, Chapters 7, 12

- 7.1, Taylor Series Methods (2 weeks)
  Refresher on Differential Equations. Euler's Method. Higher-order Taylor Series Methods.
- 7.2 Runge-Kutta Methods (1 week)
  Runge-Kutta vs Taylor Series Methods. Order 2 method. Order 4 method.
- 7.3 Stability and Adaptive Runge-Kutta Methods (1 week)
  Adapative Runge-Kutta-Fehlberg. Adams-Bashforth-Moulton Method. Stability analysis.
- 7.4 First Order Systems and Higher Order Systems (1 week)
  Systems of ODE. Taylor's Theorem in Many Variables. Autonomous ODEs.
- 7.5 Adams-Bashforth-Moulton Methods (1 week)
  Systems of ODE. Taylor's Theorem in Many Variables. Autonomous ODEs.
- (not in book) Boundary Value Problems and Shooting Methods. (1/2 week)
  Boundary-value problems in general. Basic algorithm. Refinements.
- 12.1-12.3 Introduction to Partial Differential Equations
  Linear and quasi-linear PDE. Characteristic form. Elliptic, Parabolic, and Hyperbolic PDE.
- Elliptic Boundary Value Problems.
  Grid Methods. Variational Methods. The method of finite elements.

First Project Due: ODE problem solving.

Part II: Numerical Linear Algebra. Demmel, Chapters 1, 2, 3, 6

- Chapter 1. Introduction to Numerical Linear Algebra (1 week)
  Standard problems. Matrix Factorizations. Condition Numbers. Vector and Matrix Norms.
- Chapter 2. Solving Linear Equations (2 weeks)
  Perturbation theory. Gaussian elimination. Error analysis. Iterative refinement. Blocking and parallelism. CUDA and GPU computation. Special linear systems.
- Chapter 3. Linear Least Squares Problems (2 weeks)
  Normal equations. QR decomposition. SVD. Perturbation theory. Orthogonal matrics. Householder transformations. Rank-Deficient problems.
- Chapter 6. Iterative methods in Numerical Linear Algebra (2 weeks)
  Connection with PDE solvers. Jacobi's method. Gauss-Seidel. Successive Overrelaxation (SOR). Chebyshev acceleration. Radiosity problem.

Final Project Due: Numerical Linear Algebra.

1. Prerequisites

Students are expected to have MATH 2500 and MATH 3000. MATH 2700 would help. MATH 4500 is a formal prerequisite, but it is not entirely needed, especially for graduate students. Numerical mathematics is done on computers. **The course requires substantial Mathematica programming.**

2. Course Goals

Students will develop fluency with two topics in numerical mathematics; solution of differential equations, and numerical linear algebra. Students will learn the theoretical background behind methods used to solve these problems and be able to code the methods themselves and apply them to solve particular problems drawn from applications.

Students will have met the standards of the course when they can solve a realistic applied math problem on their own using a combination of independent research, mathematical analysis, and programming.

3. Disclaimer

The course syllabus is a general plan for the course; deviations announced to the class by the instructor may be necessary.

4. Principal Course Assignments and Mathematica

Homework will be due more or less weekly. Much of the homework will use Mathematica. The Math Department has a site license for Mathematica 8 which allows students to get copies for personal or home use. This course assumes that you have access to a computer on which you can install Mathematica and use it for some longer projects and assignments. You can get access to the machines in the *Laboratory for Experimental Mathematics* in room 640, which have Mathematica installed. The course projects will involve significant Mathematica programming.

5. How to obtain Mathematica

Once you have your license, you can download your copy of Mathematica by visiting `https://sitesoft.uga.edu/mathematica` with your MyID and password.

6. Grading and WP/WF policies

The overall course grade is computed from homework and project grades by the formula:

(1) 40% for each of the projects.
(2) 20% for homework assignments.

In order to receive a grade of "WP" before the first project due date, you must have scored at least 50 % of the homework points available by the date of withdrawal. After the first project due date, this policy will remain in force for a two week grace period. After this period expires, you must have scored at least 50 % of the homework points **and** 50 % of the first project points in order to receive a grade of "WP".

7. Attendance Policy

Students are expected to attend class. Students who miss more than 6 classes (two weeks of class) may be withdrawn from the course by the instructor. The WP/WF policy above applies to students withdrawn by the instructor.

8. Academic Honesty

As a University of Georgia student, you have agreed to abide by the University's academic honesty policy, "A Culture of Honesty," and the Student Honor Code. All academic work must meet the standards described in "A Culture of Honesty" found at: `www.uga.edu/honesty`. Lack of knowledge of the academic honesty policy is not a reasonable explanation for a violation. Questions related to course assignments and the academic honesty policy should be directed to the instructor.

It is perfectly acceptable to work on homework problems in groups in this course. However, the help you should get from your fellow students should enable you to complete the problem on your own. Recruiting another student to complete the homework for you, or to simply provide answers to the problems, is a violation of the honesty policy.

9. Required Course Material

The course textbooks (Cheney and Kincaid and Demmel) are required for the course. In addition, it is assumed that each student owns a computer on which they can install Mathematica. **If you do not personally own and like to use a computer, you are not the target audience for this course. It is recommended that you reconsider enrolling.**

10. Make-up Examinations

This course has no examinations, only projects. These are due in class. Late projects will not be accepted without a very good reason (usually medical or legal).