**Math 222 (Scientific Computing: Continuous Systems)** **Spring 2011**

**Instructor:** Rob Manning, rmanning@haverford.edu, 896-1210, KINSC H207C

**Office Hours:** W 12:30-2 PM, Th 2-4 PM, plus W 7-9 PM (in the MQC), or arrange another time with me

**Prerequisites:** Math 114 or 115, or advanced placement, or permission of the instructor

**Text:** "Numerical Computing with Matlab", Revised Reprint, by Cleve Moler (SIAM, 2004), supplemented by class notes (and possibly other distributed material) in areas not sufficiently covered by the Moler text

**Course Philosophy:** The goal of the course is to provide a bridge between the theoretical and practical aspects of scientific computing, so that you will understand the mathematical ideas behind several numerical algorithms and know how to apply them to solve problems in your major discipline. It is not a cookbook course on how to use algorithms, nor is it a class purely on the theory of algorithms. Within most topics, there will be a progression from basic conceptual material to more practical implementation issues, and homework will reflect this balance, with a mix of theoretical problems and applied "programming" problems, often with a choice of applications from among the natural, physical, or social sciences. We will spend a portion of most class meetings having you work (usually in pairs) on Matlab to be prepared for, or to get started on, these applied problems.

This course focuses on continuous problems, where ideas from calculus are used in designing algorithms; a partner course (CS/Biology 186) focuses on discrete problems (and the two courses form the core sequence for the concentration in Scientific Computing). In many topics, we will begin with one-variable problems, exploring the role of one-variable calculus (especially Taylor expansions), and then move to multivariable problems, where we will introduce a few key ideas from linear algebra to generalize the algorithms. Math 215 (Linear Algebra) is not a prerequisite of the course; we will develop as we go a primer of the basic ideas from linear algebra that we need.

**Assignments:** HW most weeks, due on Fridays by 1 PM (bring to box outside my office, since the class does not meet on Fridays).

**Exams:** Take-home midterm exam due 3/3, take-home final exam during finals period.

**Grades:** The semester's grade will be based on:
Homework : 30%
Exams: 35% each

**Collaboration:** I encourage you to discuss the non-computer homework with other students in the class and/or with me. What you turn in should reflect your personal understanding of the problems, so you must write the solutions yourself without referring to notes from your collaborative work. If you find you are not able to do this, then probably you have not yet fully understood that particular problem, so you should scrap your solution and come ask me questions.

For computer problems, you may work in pairs and together submit one solution. **Absolutely no cutting and pasting of code (or anything of that nature) from anyone other than your partner for that problem.** On these collaborative computer problems, you should be sure you understand in detail the solution your pair submits; the exams will involve some programming problems that you will need to do on your own.

There will be no collaboration allowed on the exams.

## Anticipated Schedule

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| Week 1 (1/18, 1/20) | Solving linear systems (Ch. 2), intro to Matlab (in-class tutorial) |
| Week 2 (1/25, 1/27) | Accuracy of linear system-solves (Sec. 1.7, Ch. 2) |
| Week 3 (2/1, 2/3) | Interpolation (Ch. 3) |
| Week 4 (2/8, 2/10) | Solving nonlinear equations (Ch. 4) |
| Week 5 (2/15, 2/17) | Solving multiple nonlinear equations (outside material) |
| Week 6 (2/22, 2/24) | Optimization (Sec. 4.10 and outside material) |
| Week 7 (3/1, 3/3) | Least Squares (Ch. 5), Midterm due 3/3 (on material thru Wk 6) |
| SPRING BREAK | |
| Week 8 (3/15, 3/17) | Initial Value Problems for ODEs (Ch. 7) |
| Week 9 (3/22, 3/24) | Fourier Analysis (Ch. 8) |
| Week 10 (3/29, 3/31) | Random Numbers and Simulation (Ch. 9) |
| Week 11 (4/5, 4/7) | Eigenvalue and Singular Value Problems (Ch. 10) |
| Week 12 (4/12, 4/14) | Boundary Value Problems for ODEs (outside material) |
| Week 13 (4/19, 4/21) | Boundary Value Problems con't, PDF (Ch. 11) |
| Week 14 (4/26, 4/28) | PDEs con't |
| Exam period | Final Exam due by end of final exam period |