Numerical Computing  
MATH-4800  
Summer 2016

Instructor: Mark H. Holmes  
Email: holmes  
Office: Amos Eaton 322  
Office Hours: M-F 11:30-12:30

Tentative Outline

I. Fundamentals of Scientific Computing (2 days)  
   a) Overview and introduction to MATLAB  
   b) Floating-point representation  
   c) Computer arithmetic and loss of significance

II. Nonlinear Equations (3 days)  
   a) Bisection  
   b) Newton's method  
   c) Secant method

III. Numerical Solution of Linear Systems (5 days)  
   a) LU factorization  
   b) Error analysis, residuals and accuracy  
   c) Cholesky factorization

IV. Interpolation (5 days)  
   a) Polynomial interpolation  
   b) Piecewise polynomial interpolation

V. Numerical Integration (3 days)  
   a) Elementary methods  
   b) Gaussian quadrature

VI. Numerical Differentiation and Numerical Solution of IVPs (5 days)  
   a) Numerical differentiation  
   b) Elementary methods  
   c) Runge-Kutta methods

VII. Unconstrained Optimization (5 days)  
   a) Least squares  
   b) Conjugate gradient method  
   c) Nelder-Mead algorithm

Course Web-site: http://eaton.math.rpi.edu/faculty/Holmes/Courses/NumComp/Sum16/

Textbook: Introduction to Scientific Computing and Data Analysis by Mark H. Holmes ($60)
References

Numerical Analysis (2nd Ed) by Sauer
Comment: Have used it for text and other instructors still use it ($150).

Scientific Computing, an Introductory Survey (2nd ed) by Heath
Comment: Not bad, at least at the beginning, and lots of problems and have used it for text ($238).

Numerical Methods with MATLAB by Recktenwald
Comment: A lot is done well but there are some serious mistakes and have used it for text ($95).

Numerical Analysis by Burden and Faires
Comment: Widely used text but why is hard to explain ($296).

Numerical Computing with MATLAB by Moler
http://www.mathworks.com/moler (electronic edition - this is free)

Grading

Homework: 100%

Difficulty Level and Prerequisites
This course requires mathematical maturity and familiarity with the basic concepts from calculus, matrix algebra, and differential equations (MATH-2400 is a corequisite for the course). Very little time, if any, will be spent reviewing these background skills and concepts. It is not expected that you are familiar with any computing language but it is required that you have MATLAB installed on your computer (we will use it a lot).

Course Objectives
The overall objective is simple: learn the basic methods used in scientific computing. This isn’t so straightforward, and a quote due to Yogi Berra is particularly relevant to numerical computing, and it’s “In theory there is no difference between theory and practice. In practice there is.” What this means is that we will spend considerable time investigating error, where it comes from and how to control it. In conjunction with this we will consider the basic theory underlying the methods as well as learn how to implement the methods using MATLAB. Another important objective is that you learn to communicate your results in a clear and concise manner. As Billy Crystal, aka Fernando on SNL, would say, “It is better to look good than to feel good.” In other worse, this objective will border on the superficial but it is important and it will be used in grading your homework.

Attendance, Course Material and Exams
Attendance is very strongly recommended as you will be responsible for any information given out in class.

Academic Integrity
You are free to seek advice from any person, book, or computer. However, there should be no collaboration on the homework, and what you hand in must be your own work. In this regard, computer files must not be shared or exchanged nor should you copy work from someone else. Violating this policy will result in a score of zero for the assignment.

Grade Appeals
Appeals must be made within one week of the date the item is returned in class. It is important that you keep all the returned material for the entire semester as they will be your only method for correcting any recording errors that may accidentally occur on my part.

Late Policies
Late homework is usually not accepted without a legitimate excuse. If you have an excuse, you should contact me as soon as possible and I may ask for verification.