

Numerical Computing
MATH-4800
Fall 2019

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Tentative Outline

- I. Fundamentals of Scientific Computing (1 week)**
- a) Overview and introduction to MATLAB
 - b) Floating-point representation
 - c) Computer arithmetic and loss of significance

- II. Nonlinear Equations (1.5 weeks)**
- a) Bisection
 - b) Newton's method
 - c) Secant method

- III. Numerical Solution of Linear Systems (2 weeks)**
- a) LU factorization
 - b) Error analysis, residuals and accuracy
 - c) Cholesky factorization

Exam 1 (about Oct 3)

- IV. Interpolation (2 weeks)**
- a) Polynomial interpolation
 - b) Piecewise polynomial interpolation

- V. Numerical Integration (1.5 weeks)**
- a) Elementary methods
 - b) Gaussian quadrature

Exam 2 (about Nov 4)

- VI. Numerical Differentiation and Numerical Solution of IVPs (2 weeks)**
- a) Numerical differentiation
 - b) Elementary methods
 - c) Runge-Kutta methods

- VII. Unconstrained Optimization (2 weeks)**
- a) Least squares
 - b) Conjugate gradient method
 - c) Nelder-Mead algorithm

Exam 3 (about Dec 9)

Course Web-site: <http://eaton.math.rpi.edu/faculty/Holmes/Courses/NumComp/F19/>

Textbook: *Introduction to Scientific Computing and Data Analysis* by Mark H. Holmes

References

Numerical Analysis (3rd Ed) by Sauer

Comment: It has been used as text for the course.

Scientific Computing, an Introductory Survey (2nd ed) by Heath

Comment: Not bad, at least at the beginning, and lots of problems (have used it for text)

Numerical Methods with MATLAB by Recktenwald

Comment: A lot is done well but there are some serious mistakes (have used it for text)

Numerical Analysis by Burden and Faires

Comment: At one time it was the most widely used text

Numerical Computing with MATLAB by Moler

<http://www.mathworks.com/moler> (electronic edition - this is free)

Grading

Homework: 25%, Exams 75% (no final exam)

Comments: 1) No homework score will be dropped. 2) Grade modifiers are not used.

Difficulty Level and Prerequisites

This course requires mathematical maturity and familiarity with the basic concepts from calculus (particularly Taylor's theorem), 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 words, 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

In the course outline, where possible, the relevant sections of the text are indicated. However, the text does not include all of the material that will be covered. For this reason alone class attendance is very strongly recommended as you will be responsible for any information given out in class.

Academic Integrity

Do not copy or cheat during exams. With respect to homework, you are free to seek assistance or advice from any person, book, or computer. However, 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. Also, all the rules and policies in the Rensselaer handbook should be followed.

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. Missing an exam without a legitimate excuse results in a grade of zero and cannot be made up. If you have an excuse, you should contact me as soon as possible and I may ask for verification.