Introduction to Numerical Analysis - Math 104B
Summer 2011
Monday to Thursday, 12:30-13:35 pm, Girvetz 1116

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Office Hours: Tuesday & Thursday, 10:00-11:30 am.

Textbook: *Numerical Analysis*, by Richard L. Burden and J. Douglas Faires, 8th edition.

Course description: This is the second part of a three-quarters introductory course on Numerical Analysis. The focus this quarter will be the numerical solution of linear systems of equations and eigenvalue problems. We will also study families of orthogonal polynomials and their approximation properties. Although the emphasis will be in applications, the course will have a strong theoretical component.

Prerequisites: Math 5 A, B, and C or equivalent. Knowledge of a computer language suitable for numerical computing: FORTRAN, C, C++, or Matlab.

Assignments and grading: Homework will be assigned on Thursday, and will be collected at the beginning of the class on the following Thursday. Late homework will not be accepted. If you have a predictable absence, you will need to hand it in earlier. The homework will generally consist of some theoretical questions, and some computational assignments. You will be required to write a program to solve certain problems. The program must be given to me as part of the assignment, together with the output of the program, in the format indicated in the assignment, and an interpretation of the results whenever necessary. You can write the programs either in FORTRAN, C, C++, or Matlab. The book comes with a CD that contains the code for the problems. You may use this code as a guide, but you must write your own original code for the assignments. No credit will be given for using the code in the CD. Only solutions obtained using your own code will be accepted, unless stated otherwise. This rules out automatic solvers in calculators, Matlab, and any symbolic computation in Maple (such as differentiation, integration, etc.). For example, to solve a system of equation, you must write one of the methods that we study in class. The backslash operator in Matlab cannot be used, except to debug your code.

There will be a midterm and a final exam. The final exam will be split into a take-home, computationally oriented exam, and an in-class, more theoretical exam. Your final grade for the course will be decided according to the following scheme:

Final Grade = 20% Homework + 30% Midterm + 50% Final.

You must obtain 50% or more in the Final exam.

- The Midterm exam will be in the fourth week of class: August 15th-18th.
- The Final exam will be in the last session: September 8th

I will not hand out *practice exams* or anything like that. As part of the course, you should develop the necessary skills to study this subject. In order to help you study, I will periodically post *Self-Assessment* questions. You do not need to hand them in. Those questions will help you know whether you are studying effectively or not, and whether you need to review some parts of the material covered in class.

Syllabus: During this course we will try to cover each of the four chapters of the textbook in approximately 6 sessions (one and a half weeks) each. However, much like everything said earlier, this is subject to change.

Sessions 1-6: Chapter 6 – Direct Methods for Solving Linear Systems.

1. Linear Systems of Equations.
2. Pivoting Strategies.
3. † Linear Algebra and Matrix Inversion.
4. † The Determinant of a Matrix.
5. Matrix Factorization.
6. Special Types of Matrices.

Sessions 7-12: Chapter 7 – Iterative Techniques in Matrix Algebra.

1. Norms of Vectors and Matrices.
2. Eigenvalues and Eigenvectors.
3. Iterative Techniques for Solving Linear Systems.
4. Error bounds and Iterative Refinement.
5. ⋆ The Conjugate Gradient Method.

Sessions 13-18: Chapter 8 – Approximation Theory.

1. Discrete Least Squares Approximation.
2. Orthogonal Polynomials and Least Squares Approximation.
3. Chebyshev Polynomials and Economization of Power Series.
4. ⋆⋆ Rational Function Approximation.
5. ⋆⋆ Trigonometric Polynomial Approximation.
6. ⋆⋆ Fast Fourier Transforms.

Sessions 19-24: Chapter 9 – Approximating Eigenvalues.

1. † Linear Algebra and Eigenvalues.
2. The Power Method.
3. Householder's Method.
4. The QR Algorithm.

† Material already known from Math 3C and 5A

⋆ Time allowing

⋆⋆ Time allowing (very little probability)