KOÇ UNIVERSITY

Math 504 (Fall 2011) - Numerical Methods I
Syllabus

Instructor
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Lecture Hours and Location
Monday, Wednesday 12:30-13:45 at ENG B05

Textbooks
(1) Numerical Linear Algebra by Lloyd N. Trefethen and David Bau
(2) Fundamentals of Matrix Computations, 2nd Ed by David S. Watkins

We will try to follow the textbook by Trefethen&Bau as closely as possible. This is a nicely written introductory book that presents an overview of fundamental algorithms in numerical linear algebra without a detailed analysis. On certain topics we will have to go deeper than Treftehen&Bau. We will depend on the book by Watkins on these occasions. Both of the textbooks will be available at the reserve desk in the library.

Supplementary Books
Brief notes on IEEE arithmetic by Overton is available on the course webpage. If you think you will be frequently involved in IEEE arithmetic, this book is relatively cheap when bought from the SIAM website (http://www.siam.org). The book by Golub and Van Loan (will be made available at the reserve desk in the library) is a classical reference book in numerical linear algebra.

- Numerical Computing with IEEE floating point arithmetic by Michael L. Overton
- Numerical Computing with Matlab by Cleve Moler
  (Available at http://www.mathworks.com/moler/index_ncm.html)
- Matrix Computations, 3rd Ed by Gene H. Golub and Charles F. Van Loan

Prerequisites
Knowledge of elementary linear algebra is required. Computations will be performed in

Matlab. Familiarity with Matlab or any other programming language may help, but is not required. The course will be as self-contained as possible. The basic linear algebra concepts will be reviewed whenever they are necessary.

For your convenience two elementary books on linear algebra are listed below.

- Linear Algebra and its Applications, 4th Ed by Gilbert Strang
- Linear Algebra and its Applications, 3rd Ed by David C. Lay

Course Webpage
`http://home.ku.edu.tr/∼emengi/teaching/math504/math504.html`

Grading
Homeworks will be assigned once every two weeks. There will be two midterms and a final. Your overall grade will be determined based on the following scheme.

Total Score = %20 (Homework Score) + %20 (Midterm 1) + %20 (Midterm 2) + %40 (Final)

Midterms
The midterms will be held in the evenings during the weeks of October 24th-28th (6th week) and December 5th-9th (11th week). The precise dates and times will be decided in the class. Both of the midterms will be open book exams. Everything covered in class until the end of the previous week is included in each midterm.

Final
All of the topics covered in class throughout the semester are included. Date, time and location of the final will be announced later towards the end of the semester. The final will be an open book exam.

Homeworks
The homeworks will normally be assigned once every two weeks. Your homework score will be the average of six homeworks. Half of the homework questions will be conceptual. The remaining half will be computational and require performing computations in Matlab.

Description
The course covers various topics from numerical linear algebra. Most of the emphasis will be put on the numerical solutions of linear systems of equations, least squares problems (the best approximate solution for an inconsistent linear system), eigenvalue problems, and singular value problems. We will develop numerical algorithms for these four main-stream problems, and analyze the accuracy and efficiency of the numerical algorithms developed. For the numerical solutions of the problems matrix factorizations will be introduced, and their existence and uniqueness will be discussed. The Krylov-subspace based iterative algorithms will be studied as much as time permits.

Course Calendar

(Week 1) Fundamentals: Linear Algebra Review (Vector Spaces, Linear Transformations)

(Week 2) The Singular Value Decomposition

(Week 3) Applications of the Singular Value Decomposition

(Week 4) Projectors

(Week 5) QR Factorization, Gram-Schmidt, Householder Reflectors

(Week 6) QR Factorization by Householder Reflectors, Least Squares Problem
Midterm 1, October 24th-28th (Covers weeks 1-5)

(Week 7) Pseudoinverse, Condition Numbers

(Week 8) Backward Error Analysis

(Week 9) Linear Systems, Gaussian Elimination

(Week 10) Pivoting

(Week 11) Backward Error Analysis of the Gaussian Elimination with Pivoting
Midterm 2, December 5th-9th (Covers weeks 1-10)

(Week 12) Eigenvalues, Similarity Transformations, Schur Factorization

(Week 13) Power Iteration and Extensions, QR Algorithm

(Week 14) Convergence Analysis of the QR Algorithm, Arnoldi Iteration