Math 504 (Fall 2018) - Numerical Methods I
Syllabus

Description
Majority of the numerical algorithms rely on the solutions of linear algebra problems. In the end whether these algorithms are worthy for common use translates into whether the associated linear algebra problems can be solved efficiently and accurately.

The main purpose of the course is to feature modern numerical approaches for the solutions of linear algebra problems including systems of linear equations, eigenvalue problems, singular value problems. But applied linear algebra tools, such as matrix factorizations, projectors, reflectors without which modern numerical algorithms cannot exist, will also be introduced throughout.

Both direct approaches and iterative approaches will be covered. Thorough analyses of how rounding errors affect the accuracy will be presented for direct approaches. The course concludes with extensions of iterative methods to systems of nonlinear equations, where Newton's and quasi-Newton methods as well as their convergence are discussed.

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Lecture Hours and Location
Tuesday-Thursday 11:30 - 12:45 at SCI 129

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

Resources and Textbooks
My lecture notes will be accessible on the course webpage.
Additionally, the books below may be helpful.
(1) Numerical Linear Algebra by Lloyd N. Trefethen and David Bau
(2) Iterative Methods for Linear and Nonlinear Equations by C. T. Kelley

The first book is available at the reserve desk in the library. The second one is freely available on the web at the following address.
https://www.siam.org/books/textbooks/fr16_book.pdf

Purposes
– Direct and iterative solutions of linear systems
– Direct and iterative computation of eigenvalues
– Solutions of systems of nonlinear equations
– Analyzing the effects of rounding errors on an algorithm
– Matrix factorizations such as SVD, QR, Schur, LU
– Tools from linear algebra such as projectors, reflectors, rotators, pseudoinverse

Grading

$$\text{Total Score} = \%30\ (\text{Midterm}) + \%40\ (\text{Final}) + \%30\ (\text{Homeworks})$$

The final will also count for the midterm if it is higher than the midterm.

Important Enrollment Dates

- September 17, Monday — First Day of Classes
- September 7-21 — Add-Drop Period
- October 29, Monday — Foundation of Turkish Republic
- December 21, Friday — Last Day of Classes
- December 26 - January 7 — Final Period

Course Calendar
This calendar is tentative. The precise duration on various topics are likely to change.

– Week 1 (Sep 17): Background
– Week 2 (Sep 24): Singular value decomposition and applications
– Week 3 (Oct 1): Projectors, pseudoinverse
– Week 4 (Oct 8): Sensitivity and conditioning
– Week 5 (Oct 15): QR factorization, Householder reflectors, rotators
– Week 6 (Oct 22): Least squares problem, linear systems
– Week 7 (Oct 29): Classical stationary iterative methods for linear systems
– Week 8 (Nov 5): Krylov Subspace Methods for Linear Systems
– Week 9 (Nov 12): Computation of extreme eigenvalues
– Week 10 (Nov 19): Computation of all eigenvalues
– Week 11 (Nov 26): Fixed-point iteration
– Week 12 (Dec 3): Newton's method for nonlinear systems
– Week 13 (Dec 10): Broyden's method for nonlinear systems
– Week 14 (Dec 17): Review