Math 477 – Numerical Linear Algebra

Course Description from Bulletin: Fundamentals of matrix theory; least squares problems; computer arithmetic, conditioning and stability; direct and iterative methods for linear systems; eigenvalue problems. (3-0-3)

Enrollment: Elective for AM and other majors.

Textbook(s): Lloyd N. Trefethen and D. Bau, *Numerical Linear Algebra*, SIAM (1997), ISBN 0-89871-361-7.
D. Kincaid and W. Cheney, *Numerical Analysis: Mathematics of Scientific Computing*, 3rd Ed, Brooks/Cole (2002), ISBN 0-534-38905-8.

Other required material: Matlab

Prerequisites: MATH 350 Introduction to Computational Mathematics or MMAE 350, or consent of the instructor

Objectives:

1. Students will learn the basic matrix factorization methods for solving systems of linear equations and linear least squares problems.
2. Students will learn basic computer arithmetic and the concepts of conditioning and stability of a numerical method.
3. Students will learn the basic numerical methods for computing eigenvalues.
4. Students will learn the basic iterative methods for solving systems of linear equations.
5. Students will learn how to implement and use these numerical methods in Matlab (or another similar software package).

Lecture schedule: 3 50 minutes (or 2 75 minutes) lectures per week

Course Outline:	Hours
1. Fundamentals	5
a. Matrix-vector multiplication	
b. Orthogonal vectors and matrices	
c. Norms	
d. Computer arithmetic	
2. Singular Value Decomposition	3
3. QR Factorization and Least Squares	8
a. Projectors	
b. QR factorization	
c. Gram-Schmidt orthogonalization	
d. Householder triangularization	
e. Least squares problems	
4. Conditioning and Stability	5
a. Conditioning and condition numbers	
b. Stability	
5. Systems of Equations	5
a. Gaussian elimination	

   b. Cholesky factorization
6. Eigenvalues 8
   a. Overview of eigenvalue algorithms
   b. Reduction to Hessenberg or tridiagonal form
   c. Rayleigh quotient, inverse iteration
   d. QR Algorithm without and with shifts
   e. Computing the SVD
7. Iterative Methods 8
   a. Overview of iterative methods
   b. Arnoldi iteration
   c. GMRES
   d. Conjugate gradients
   e. Preconditioning

Assessment:	Homework	10-30%
	Computer Programs/Project	10-20%
	Quizzes/Tests	20-50%
	Final Exam	30-50%

Syllabus prepared by: Greg Fasshauer and Xiaofan Li
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