Math 532 – Linear Algebra

Course Description from Bulletin: Matrix algebra, vector spaces, norms, inner products and orthogonality, determinants, linear transformations, eigenvalues and eigenvectors, Cayley-Hamilton theorem, matrix factorizations (LU, QR, SVD). (3-0-3)

Enrollment: Elective for AM and other majors.

Textbook(s): Carl D. Meyer, *Matrix Analysis and Applied Linear Algebra*, SIAM (2000), ISBN 0-89871-454-0

Other required material: none

Prerequisites: Undergraduate linear algebra as in MATH 332, or instructor's consent

Objectives:

1. Students will reinforce their understanding of matrix algebra in the context of the LU factorization.
2. Students will understand the fundamental concepts of vector spaces.
3. Students will understand vector and matrix norms along with the concept of an inner-product space, and learn how these concepts are applied in the context of orthogonal factorization algorithms such as Gram-Schmidt, QR and SVD.
4. Students will understand eigenvalues and eigenvectors and how these concepts apply to matrix diagonalization and algorithms for computing eigenvalues and solving linear systems iteratively.

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

Course Outline: Hours

1. Matrix Algebra 4
    a. Inverse matrices and Sherman-Morrison formula
    b. Elementary matrices
    c. LU factorization
2. Vector Spaces 10
    a. (Fundamental) subspaces
    b. Linear independence
    c. Basis and dimension, rank
    d. Classical least squares
    e. Linear transformations
3. Norms, Inner Products and Orthogonality 16
    a. Vector and matrix norms
    b. Inner-product spaces
    c. Gram-Schmidt orthogonalization, QR factorization
    d. Unitary and orthogonal matrices
    e. Complementary subspaces
    f. Orthogonal decomposition
    g. Singular value decomposition

h. Orthogonal projections

4. Determinants 4
5. Eigenvalues and Eigenvectors 12
    a. Elementary properties
    b. Diagonalization, similarity transforms, Cayley-Hamilton theorem
    c. Functions of diagonalizable matrices
    d. Normal matrices
    e. Positive definite matrices
    f. Neumann series and iterative solvers
    g. Krylov methods

Assessment:	Homework	10-30%
	Tests	20-50%
	Final Exam	30-50%

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