EE 510 LINEAR ALGEBRA FOR ENGINEERING (4 units)

FALL 2022

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Office Hours: Monday 12pm-2pm (PST)

Location EEB 524

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Graders: Krishna Kamal Adidam, adidam@usc.edu

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Lecture: Tue, Thu 1:30-3:20pm, OHE136, DEN@Viterbi

Discussion: Friday 9:00am-9:50am, OHE136, DEN@Viterbi

Lecture: Mon, Wed 5:30pm-7:20pm, GFS 116

Discussion: Friday 2:00pm-2:50pm, GFS 116

Webpages:

DEN

Prerequisites: Prior courses in multivariate calculus, linear algebra, and linear system theory.

Other Requirements: Basic computer skills (e.g., plotting, Matlab, Excel, Python, etc.).

Grading:

Assignments 20pts

Two Midterm Exams 25 pts+25pts=50pts

Final Exam 30pts

Letter Grade Distribution:

100.00-93.00 A	73.00 - 76.99 C
90.00 - 92.99 A-	70.00 - 72.99 C-
87.00 - 89.99 B+	67.00 - 69.99 D+
83.00 - 86.99 B	63.00 - 66.99 D
80.00 - 82.99 B-	60.00 - 62.99 D-
77.00 - 79.99 C+	59.99- F

The letter grade distribution table guarantees the minimum grade each student will receive based on their total final score.

Catalogue Description: Introduction to linear algebra and matrix theory and their underlying concepts; applications to engineering problems; mathematically rigorous and foundational to other classes in communication, control, and signal processing.

Course Objectives: In this course the student is expected to acquire a good working knowledge and understanding of the underlying theoretical concepts of:

vector spaces, linear independence, bases, dimension, the properties and importance of linear transformations, fundamental subspaces of linear transformations ,representation of linear transformations by matrices, solving systems of linear equations and methods to that aim, definition and properties of pseudo-inverse, eigenvalues and eigenvectors their importance and calculation, definition and properties of singular value decomposition, canonical forms of matrices, similarity and congruence for matrices ,inner-product spaces, the matrix exponential and other functions of matrices. The student will also be exposed to engineering problems relying on the utilization of linear algebra such as: linear least squares problem and other optimization problems, concepts of controllability and observability.

Exam Dates:

Midterm Exam 1: TBA

Midterm Exam 2: TBA

Final Exam: Monday,Dec.12 ,4:30pm-6:30pm

Textbooks:

Suggested Textbook: Strang, Gilbert, Linear Algebra and its Applications, 4th ed., Thomson Learning Co.,

2006.

In the course we follow this text to a large extent.

Handouts on certain topics will be distributed.

Other recommended Textbooks:

1. Ortega, James M. Matrix theory: A second course, Springer Science & Business Media,

2013.

2. Lang, Serge. Introduction to Linear Algebra. Springer Science & Business Media, 2012.

3. Rosen, Kenneth H., and Hautus, Malo J., Handbook of linear algebra, CRC Press, 2007.

4. Laub, Alan J., Matrix analysis for scientists and engineers. SIAM, 2005.

5. Meyer, Carl D., Matrix analysis and applied linear algebra. SIAM, 2000 Laub, Alan J. Computational matrix analysis, SIAM, 2012.

6. Lay, David C., and Steven R. Lay, Linear algebra and its applications, 5th ed., Addison-Wesley, 2015.

7. Roger A. Horn and Charles R. Johnson, Matrix Analysis 2nd Edition, Cambridge University Press 2013, and Topics in Matrix Analysis, Cambridge University Press 1991.

8. D.Finkbeiner, Introduction to Matrices and Linear Transformations, Freeman &Co., 1966.

The books by Horn and Johnson have a lot of very useful material, a variety of topics and are used as standard reference.

Homework is assigned on a weekly /biweekly basis. No late homework will be accepted.

Exam Policy

No make-up exams.

Exceptions: In case of emergency a signed letter from your manager or physician must be submitted. This letter must include the contact of your physician or manager.

Midterms and final exams will be closed book and notes. No calculators are allowed nor are computers and cellphones or any devices that have internet capability. One letter size cheat sheet (back and front) is allowed for the midterms. Two letter size cheat sheets (back and front) are allowed for the final.

All exams are cumulative, with an emphasis on material presented since the last exam.

Attendance:

Students are expected to attend the lectures and discussion sessions and actively participate in class discussions.

Important Notes:

Textbooks are secondary to the lecture notes and homework assignments.

By "Material covered and examined" is meant what is taught in class.

Handouts and course material will be distributed.

COURSE OUTLINE (Roughly following Strang's text and the Handouts)

Chapter 1

1.2 The Geometry of Linear Equations

1.3 An Example of Gaussian Elimination

1.4 Matrix Notation and Matrix Multiplication

1.5 Triangular Factors and Row Exchanges

1.6 Inverses and Transposes

1.7 Special Matrices and Applications

Chapter 2

2.1 Vector Spaces and Subspaces

2.2 Solving Ax = 0 and Ax = b

2.3 Linear Independence, Basis, and Dimension

2.4 The Four Fundamental Subspaces.

2.6 Linear Transformations

Inner Product Spaces

Chapter 3

3.1 Orthogonal Vectors and Subspaces

3.2 Cosines and Projections onto Lines

3.3 Projections and Least Squares

3.4 Orthogonal Bases and Gram-Schmidt Orthonormalization Procedure

Chapters 4, 5, 6

Eigenvalues and Eigenvectors

5.2 Diagonalization of a Matrix

Appendix B Jordan form

Cayley Hamilton Theorem

Minimal Polynomial of a Matrix

Gershgorin circle theorem

5.3 Difference Equations and Powers A^k

5.4 Differential Equations and exp (At)

Controllability, Observability for Discrete Time Linear Systems

5.6 Similarity Transformations

6 Positive Definite Matrices

6.1 Minima, Maxima, and Saddle Points

6.2 Tests for Positive Definiteness

6.3 Singular Value Decomposition

6.4 Minimum Principles

4.3 Formulae for the Determinant

4.4 Applications of Determinants

Chapters 7, 8

Computations with Matrices

Normed Vector Spaces

Matrix Norms and Their Properties

7.2 Matrix Norm and Condition Number

7.3 Computation of Eigenvalues

7.4 Iterative Methods for Ax = b

Conjugate Directions Methods for Ax = b

Appendix A

A.4 The Tensor Product of Two Vector Spaces *

A.5 The Kronecker Product A-B of Two Matrices, Applications

Topics I

Cholesky and Modified Cholesky factorization

Perron-Frobenius Theorem, Markov Chains

Theorems of the Alternative, Farkas' Lemma, KKT conditions

Fourier-Motzkin method for Linear Inequalities

Vandermonde Matrix, Applications and Lagrange Interpolation

Resultants

8.1 Linear Inequalities, Linear Programming formulation

Linear Matrix Inequalities (LMI's), Parrott's Theorem and Applications

Approximation of a Matrix by one of Lower Rank (Eckart Young Theorem)

Topics II *

8.5 Game Theory*

Stability of Linear Dynamical Systems (Routh, Hurwitz, Lyapunov), Applications*

2.5 Graphs and Networks *

8.4 Network Models *

Note: Items marked by * may be covered only if time permits.