Advanced Linear Algebra
MATH430
Course information

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Students on UI Moscow campus in fall and spring: You are encouraged to make appointments with me or use my office hours (posted on my office door) to get help with the material. I'll be happy to clarify any ambiguity in the lectures and to give pointers if you are stuck on a particular problem, however, I shall not work on your homework assignment with you nor will I check your solutions for errors in my office.

All students: When a meeting is not possible, do not hesitate to communicate any issues by email. Please follow some basic email courtesy. Emails without any address or signature can be ignored.

Text: S. Friedberg, A. Insel & L. Spence, *Linear Algebra*, 4th Edition, 2003.

Course webpage: www.webpages.uidaho.edu/sdatta/EOmath430.html

Course outline:

- Vector Spaces
  - Definition and examples of vector spaces and subspaces
  - Linear independence and linear dependence
  - Basis and dimension
- Linear Transformations and Matrices
  - Null space and range of a linear transformation
  - The matrix representation of a linear transformation
  - Change of coordinate system
- Elementary Matrix Operations and Systems of Linear Equations
- Determinants and properties of determinants
- Diagonalization
  - Eigenvalues and eigenvectors
  - Eigenspace of a linear transformation
  - Conditions for diagonalizability of a linear transformation
- Inner Product Spaces

  - Inner product, norm, orthogonal and orthonormal sets
  - Gram-Schmidt orthogonalization
  - Normal, self-adjoint, unitary, and orthogonal operators
  - Orthogonal projection and least squares approximation
  - Singular value decomposition of a matrix
- Jordan Canonical Form of a Matrix

In the book **S. Friedberg, A. Insel & L. Spence, *Linear Algebra*, 4th Edition, 2003** the above topics are covered in the following chapters.

- Chapter 1 - Sections 1.1 - 1.6
- Chapter 2 - Sections 2.1 - 2.6
- Chapter 3 - Sections 3.1 - 3.4
- Chapter 4 - Sections 4.1 - 4.4
- Chapter 5 - Sections 5.1, 5.2, 5.4
- Chapter 6 - Sections 6.1 - 6.7
- Chapter 7 - Section 7.1 - 7.3

Assignments, exams & grading:
Your grade in the course will be based on the following:
Homework - 20%
Midterm I (50 minutes) - 25% (after Lecture 19)
Midterm II (50 minutes) - 25% points (after Lecture 35)
Final (2 hours) - 30%

All exams will be closed-book, closed-notes, and calculators will not be allowed. The final exam is comprehensive.
Part of your grade will be based on neatness and correct mathematical notation. Your work should be organized and easy for me to read or else you will lose points.

Important deadlines: The following are the deadlines by which the above exams must be taken and returned by the proctor to the EO office:

For Fall:
Midterm I: October 15
Midterm II: November 20

For Spring:

Midterm I: March 1
Midterm II: April 15
For Summer:
Midterm I: July 5
Midterm II: July 25

Unless you have taken my permission, you should strictly abide by the dates given above. You can take a test on any day before the corresponding due date. The exams must be received by the EO office **by** the above dates, otherwise, your score for the exam will be automatically set to zero. Please make a note of the above dates so that you can make arrangements with your proctor.

As soon as you finish a lecture, work on the related problems from the assignments. You should work on the assignments alongside the lectures and turn them in as you finish. In particular, you must ensure that all HWs pertaining to a certain midterm are submitted **before** that midterm. If your assignments are poorly timed, (for example, HW 1 is submitted after Midterm 2), or turned in one batch before tests or towards the end of the semester, they will **not** be considered. Besides, in such cases, I will **not** be able to provide any feedback or inform you of your HW grades.

Please scan (if handwritten) and email me your assignments in a **single** pdf. Camera shots of pages will **not** be accepted. Write your name, course name/no., and assignment no. in the subject of the email.

Learning outcomes:

- The students will understand the ideas of vector spaces, subspaces, linearly dependent and independent sets in a vector space, bases and dimension of different vector spaces and subspaces.
- The students will learn to find the null space, range, and matrix of a linear transformation. They will be able to determine whether a linear transformation is one-to-one and onto.
- The students will learn to find the determinant of a matrix and how to use properties of determinants to find the determinant in simple ways.
- The students will learn to use eigenvectors and eigenspaces to determine the diagonalizability of a linear transformation.
- The students will understand the notion of an inner product space in a general setting and how the notion of inner products can be used to define orthogonal vectors. They will be able to use the Gram-Schmidt process to generate an orthonormal set of vectors.
- The students will learn about normal, self-adjoint, and unitary operators and their properties.

- The students will be able to find the singular value decomposition of a matrix.
- The students will learn to find the Jordan canonical form of matrices when they are not diagonalizable.

The tests will serve as an assessment tool for the learning outcomes.