Math 107 - Introduction to Linear Algebra (Spring 2020)

Course Description
Vectors; matrices and systems of linear equations; vector spaces; linear transformations; orthogonality; algebra of complex numbers; eigenvalue problems

Course Overview
This is a first undergraduate course in linear algebra. The course starts with concrete topics such as systems of linear equations, and matrices with which a typical student should already have some familiarity at elementary level. Abstract concepts such as a vector space, a linear transformation acting on the vector spaces are first introduced in connection with these concrete grounds. Second part introduces topics such as vector spaces, isomorphism, transformations in abstract terms and in a general setting. The course concludes with eigenvalue problems, and the notions of an inner product and orthogonality.

Textbook
Linear Algebra and its Applications (5th Edition)
by David C. Lay, Stephen R. Lay and Judi J. McDonald

The textbook is available at the bookstore.

Lecture Hours and Location
Section 1 (Emre Mengi) : Tue&Thr 13:00-14:15 at SOS B10
Section 2 (Emre Mengi) : Mon&Wed 11:30-12:45 at ENG B29
Section 3 (Emre Mengi) : Tue&Thr 8:30-9:45 at ENG B29
Section 4 (Mehmet Saridereli) : Tue&Thr 14:30-15:45 at SOS B21
Section 5 (Ayberk Zeytin) : Tue&Thr 8:30-9:45 at SCI Z24

Instructors

<table>
<thead>
<tr>
<th>Section</th>
<th>Office</th>
<th>Office Hours</th>
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<tr>
<td>4</td>
<td>SCI 123</td>
<td>Mon&amp;Wed 15:00 - 15:45, Thr 18:45-19:15</td>
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<td>5</td>
<td>SCI 231</td>
<td>Tue&amp;Thr 10:00 - 11:00</td>
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<td>1,2,3</td>
<td>SCI 113</td>
<td>Wed 14:30 - 16:30</td>
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You can also make appointments with the instructors for additional office hours (e.g., by sending e-mails to them).

Teaching Assistants
To be announced.

Course Webpage
http://home.ku.edu.tr/~math107

All announcements will be made through this webpage. You can also access the homeworks from this webpage.

Grading
Your grade at the end of the semester will be assessed based on two midterms, a final and attendance points, in particular the following grading scheme.

- %30 (Midterm 1) + %30 (Midterm 2) + %40 (Final) + %6 (Quizzes, Bonus)

If your final score is higher than one of your midterm scores, it will replace the score of that midterm. To be eligible for the final, the average of your midterm scores should be at least
20. A student with midterm average below 20 will fail. Please keep also in mind that there will be a curve in the end when assessing your letter grade.

**Quizzes**
The students are advised to attend the lectures and the problem sessions. There will be 4-10 quizzes that will take place at the end of the lectures. The dates of the quizzes will be randomly chosen by the instructor of the section. Each quiz will last at most five minutes, and consist of a few multiple choice or true/false questions.

**Problem Sessions**
The problem sessions meet once every week. Their purpose is to provide you the opportunity to practice with your TAs and classmates, as well as to bring questions/topics that you are having difficulty with. You can attend any problem session you prefer. Some of the questions solved in the problem sessions with minor modifications or without any modification at all are likely to appear in the midterms and in the final.

**Make-up Exams**
A student can be eligible for a make-up exam only if she/he provides proper medical reports approved by the health center at Koç University or an excuse form.

The final exam will be used as the make-up exam for the midterm exams. If a student misses the final exam for a legitimate reason, a separate make-up exam will be held after the final period.

**Important Dates and Holidays**
- January 27, Monday — First Day of Classes
- January 27-31 — Add-Drop Period
- April 6-10 — Spring Break
- April 23 — National Sovereignty and Children’s Day
- April 24 — Last Day for Withdrawal from a Course
- May 8, Friday — Last Day of Classes
- May 11-20 — Finals
Course Calendar
This calendar is only tentative, and subject to changes. The numbers in parentheses refer to the sections from the textbook by Lay, Lay and McDonald.

Week 1 (Jan 27 - 31)
Systems of Linear Equations, Row Reduction and Echelon Forms (1.1-1.2)

Week 2 (Feb 3 - 7)
Vector Equations, Matrix Equation \( Ax = b \), Solution Sets of Linear Systems (1.3-1.5)

Week 3 (Feb 10 - 14)
Linear Independence in \( \mathbb{R}^n \), Introduction to Linear Transformations (1.7-1.8)

Week 4 (Feb 17 - 21)
Matrix of a Linear Transformation, Matrix Operations (1.9, 2.1)

Week 5 (Feb 24 - 28)
Inverse of a Matrix, Characterizations of Invertible Matrices, Vector Spaces and Subspaces (2.2-2.3, 4.1)

Week 6 (Mar 2 - 6)
Null Spaces, Column Spaces, Linear Transformations on Vector Spaces, Linear Independence, Basis (4.2-4.3)

Week 7 (Mar 9 - 13)
Coordinate Systems, Isomorphism, Dimension of a Vector Space (4.4-4.5)

Week 8 (Mar 16 - 20)
Rank, Change of Bases (4.6-4.7)

Week 9 (Mar 23 - 27)
Introduction to Determinants, Properties of Determinants, Cramer’s Rule (3.1-3.3)

Week 10 (Mar 30 - Apr 3)
Eigenvalues and Eigenvectors, Characteristic Equation (5.1-5.2)

Week 11 (Apr 13 - 17)
Diagonalization, Eigenvectors and Linear Transformations, Complex Eigenvalues (5.3-5.5)

Week 12 (Apr 20 - 24)
Inner Product, Length, Orthogonality, Orthogonal Sets (6.1-6.2)

Week 13 (Apr 27 - May 1)
Orthogonal Projections, Gram-Schmidt Process, Least-Squares Problem (6.3-6.5)

Week 14 (May 4 - 8)
Inner Product Spaces, Symmetric Eigenvalue Problem, Quadratic Forms (6.7, 7.1-7.2)

May 11 - 20 : Finals
**Purposes and Learning Outcomes**

We expect a student to be equipped with the following skills at a successful completion of the course.

- Think in abstract and general terms, for instance polynomials can also be orthogonal just like ordinary vectors
- Determine whether the solution to a linear system is unique or not
- Solve a linear system by row-reduction
- A good knowledge of basic concepts about matrices such as column space, null space, rank, rank-nullity theorem
- Perform basic operations on matrices such as the calculation of the matrix inverse
- Knowledge of characterizations of invertible matrices
- The student should be able to express a determinant as a cofactor expansion
- Knowledge of the properties of the determinant operation
- A good understanding of a vector space and related notions such as a basis, linear independence, span, coordinates relative to a basis, isomorphism
- Knowledge of what a transformation is, the properties that makes a transformation a linear transformation, and notions related to linear transformation such as their kernel, range as well as their properties
- Identification of a matrix representation of a linear transformation
- Ability to represent a change of coordinates as a linear transformation and in terms of a matrix
- Knowledge of the definitions of an eigenvalue, eigenvector and eigenspace
- Ability to determine whether a matrix is diagonalizable
- Knowledge of the properties of eigenvalues and eigenvectors of symmetric matrices
- Knowledge of the definition of an inner product, orthogonality and orthogonal projection
- Ability to find an orthonormal basis for a vector space with an inner product
- Knowledge of the definition of the least-squares problem and its motivation
- Ability to express the solution of a least-squares problem as the solution of a linear system