

MATH 401 — SECTION 0601 — FALL 2022  
**APPLICATIONS OF LINEAR ALGEBRA**

TuTh 2-3:15PM — MTH 0302

**Instructor**

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Office Hours: Mon 4-5, Wed 2-3 (or by appointment)

**Grader:** not assigned yet

**Textbooks**

[1] Gilbert Strang, *Linear Algebra and Its Applications*, fourth edition, Thomson Learning Inc, 2006; ISBN 0-03-010567-6.

[2] Justin O. Wyss-Gallifent, *Applications of Linear Algebra*, <http://www.umd.edu/~immortal/MATH401/>

**Course Content**

Review of basic concepts of linear algebra with emphasis on general properties, several dimensions and computation using MATLAB based on [1]: Gaussian elimination and matrix decompositions, linearity, orthogonality and least squares, eigenvalues and singular values. Various applications of linear algebra based on [1,2]: incidence matrices, graphs and directed graphs, discretization of differential equations by finite differences and finite elements, interpolation, data fitting, Householder QR decomposition, discrete Fourier analysis and FFT, image compression, principal component analysis, pagerank, linear programming.

**Syllabus**

1. Gaussian Elimination, Matrix Factorizations and Determinants (Chapter 1 of [1])  $\approx$  3 weeks
2. Vector Spaces and Bases (Chapter 2 of [1])  $\approx$  2 weeks
3. Orthogonality and Least Squares (Chapters 3, 4, 5 of [1])  $\approx$  3 weeks
4. Eigenvalues and Eigenvectors (Chapter 8 of [1])  $\approx$  2 weeks
5. Computations with Matrices (Chapter 7 of [2] and Chapter 10 of [1])  $\approx$  1 week
6. Linear Programming and Game Theory (Chapter 8 of [2])  $\approx$  1 week

**Grading Policy**

EXAM 1 (20%):  $\approx$  October 13.

EXAM 2 (20%):  $\approx$  November 10.

FINAL (30%): Saturday December 17, 10:30-12:30. Covers all the material of the course.

HOMEWORK (20%): Homework problems will be assigned weekly and some of them, marked with a star (\*), graded. A list of the homework assignments will be posted in Canvas. Homeworks should be converted into pdf files and uploaded to Canvas.

MATLAB (10%): There will be three MATLAB assignments. Students must upload a pdf file to Canvas.

**Exam Policy**

The exams will be in-class. Make-up exams should be avoided and convincing documentation such as a doctor's note should be provided: talk to the instructor in advance. Make-up exams will have an oral component.

## USE of MATLAB

We will use the software package MATLAB, a computer system for doing linear algebra calculations. We will use MATLAB in two ways: 1) to illustrate the basic linear algebra theory we will develop; 2) to carry out certain important linear algebra calculations that cannot be done by hand. These two uses will be carefully explained in the course, but it may be useful to explain them briefly here. The solution of linear equations and the calculation of eigenvalues and singular values, are two linear algebra problems of special importance in applications, but because of the sizes of the matrices involved, they must be done on a computer; hence the importance of the second use. It is only for very small matrices or matrices of special type that these two problems, as well as many other problems, can be solved by hand. It is thus difficult to illustrate the theory of linear algebra on any but the simplest matrices by hand calculation; hence the importance of the first use. You will need the student edition of MATLAB, which is available on the MathWorks website [www.mathworks.com](http://www.mathworks.com).