ENG EK 103: Computational Linear Algebra, SP 2018

INSTRUCTOR

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Office hours: Thursdays 1:10-2:05, plus TBD

INTRODUCTION, COURSE GOALS, AND LEARNING OBJECTIVES

This is a course on understanding, manipulating, and applying linear systems of equations and, more broadly, linear relationships between variables. The ideas and tools you will learn are immensely useful in a wide variety of application domains, including physics, engineering, big data, data visualization, and more. You will become familiar with vectors and matrices, linear systems of equations, vector spaces, inner products, eigenvectors and eigenvalues and the more general singular values. You will also learn to interpret matrices as linear transformations and to understand the geometrical interpretation for operations such as solving linear systems of equations and least-squares fitting of data to models. Throughout the course, the tools will be related to specific applications to show how linear algebra is used to solve real-world problems. Examples include Google's PageRank algorithm, cryptography, coding theory, genetics, bioinformatics, image compression, linear programming (optimization), networks, and Markov chains.

COURSE PREREQUISITES

None. Matlab will be used, though I do not expect prior familiarity. If you haven't done so already, you should download and install Matlab on your computer. Information on obtaining a copy of the software can be found at:

`http://www.bu.edu/tech/support/research/software-and-programming/common-languages/matlab/`

COMPUTATION AND APPLICATION

There will be a strong emphasis on how these fundamental concepts are used to solve engineering problems. Solving small problems by hand definitely helps with understanding the concepts and is an important element of the course. However, practicing engineers often need to attack very large problems with a very large number of variables where doing things by hand is simply not feasible. As a result, and because this is a course for engineers, there will also be elements of the course aimed at helping students understand real-world use of the material. This will be done in a variety of ways. First, throughout the course examples will be presented of real world applications where linear algebra plays a major role and these applications will be connected to specific tools being learned in the course. As noted above, possible examples include Google's PageRank algorithm, cryptography, coding theory, genetics, bioinformatics, image compression, linear programming (optimization), networks, Markov chains, and more! Second, such examples will be drawn upon in the problems sets and group work. Finally, problem sets will include not just small but illustrative sample problems that are amenable to hand calculation, but (relatively) large scale problems that cannot be worked by hand but must be attacked using a computational platform such as Matlab.

COURSE EXPECTATIONS AND GRADING

It is my firm belief that learning is an *active* experience. Each lecture will be broken into two equal-length blocks. Each block will consist of twqo periods: a lecture period where I will introduce a topic, followed by a group-work period where we will all work on that topic. For this to work, it is essential that prior to class you read the assigned material and organize your thoughts and questions. As an indication of the importance of properly preparing for lecture, there will be short "did you read" quizzes for each lecture.

While this is definitely a math-oriented course, it is important to see how linear algebra is *used* in engineering. Thus, each week I will dedicate a portion of the lecture time to describe an application where linear algebra plays an important role.

While I will open each topic with a (brief?) lecture, as noted above it is expected that you will have done the reading. Thus, most of our in-class time will be spent on the activities. These will be done in groups but everyone will have to complete them and turn them in with their next homework. As usual, you are welcome to discuss the regular homework with others as well but each student must perform and submit their own work. Submitted work should be neat, organized, and legible and is to be turned in by the start of class on the due date. For problems requiring Matlab, your m-file should also be submitted electronically (by posting it to the Piazza site).

There will be two in-class exams and one final.

Your overall score will be assigned according to the following weighting:

Prep quizzes: 5%, Class activities: 15%, Homework: 15%, Exam 1: 20%, Exam 2: 20%, Final exam: 25%

A note on grading: I will do my best to return graded materials as quickly as possible. Because the specifics of grading any particular piece of work fade in a surprisingly short time, any requests for regrades must happen within **one week** of when the material is returned to you. Please note that during a regrade, I reserve the right to be increase and decrease your score, depending on what the work merits!

COURSE WEBSITE

A website has been set up on Piazza and you should have already received an invite. All course materials will be disseminated there. Note that Piazza has a nice social networking feature allowing questions to be asked and answered among yourselves; I highly encourage you to make use of it!

DROP AND WITHDRAWAL DATES

The last day to **drop** the class (without a W appearing on your transcript) is 02.22.2018.

The last day to **withdraw** from the class (with a W appearing on your transcript) is 03.30.2018.

TEXTBOOK AND REFERENCES

The primary textbook is Bernard Kolman and David R Hill, *Elementary Linear Algebra with Applications, (9th edition)*, Pearson/Prentice Hall, 2008.

There are many other textbooks on this topic. A couple of these are

1. David C. Lay, Steven R. Lay, and Judi J. McDonald, *Linear algebra and its applications, Fifth edition*, Pearson, 2015.
2. G. Strang, Introduction to Linear Algebra, Fourth Edition, Wellesley-Cambridge Press, 2009.

Prof. Strang (at MIT) offers his linear algebra course through the MIT OpenCourseWare sites. You can find lots of good videos, worked problems and exams, and other materials. Check it out at:

http://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/