MATH 222E Course Syllabus

Summer 2024

Why learn linear algebra?

Linear algebra gives a common computational tools and language for a wide variety of real-world situations. These tools are extremely useful in physics, economics, social sciences, natural sciences, engineering, and data analysis. Linear algebra lies at the heart of Google's search algorithm, ChatGPT's A.I. language model, and Pixar's graphics engines. It allows us to find patterns in large data sets and to find optimal solutions in economics, medicine, and more.

For a perspective on why it is important to learn foundational concepts in linear algebra.

- 3Blue1Brown, Essence of Linear Algebra

Prerequisites. MATH 115 or equivalent.

Text. Nicholson: Open Linear Algebra with Applications

What will we learn?

- Solve systems of linear equations and find best approximations when no solution exists.
- Develop rules for matrix algebra and algorithms for matrix factorizations.
- Model Markov chains and other linear recurrence problems.
- Model data with least-squares polynomial approximations.
- Use eigenvectors and eigenvalues diagonalize matrices and find steady-state solutions.
- Puzzle through hard problems and document your work.
- Build your communication skills in a new mathematical language.

How will we learn?

In class.

Your section will meet remotely five times a week:

Monday – Friday at 1-2:20 pm EST

In class, your instructor will introduce new concepts and processes, and you will get to practice with the material and ask questions. In addition to the instructor, you should think of your peers as an important resource for learning in class. Not only will your peers help you understand ideas from a new perspective, but also, they can give you critical feedback as you describe your own thought processes. **You are expected to attend every class and to arrive on time**. It is your responsibility to keep informed of any announcements, syllabus adjustments, or policy changes made during scheduled classes.

Before class.

It is a good idea to read ahead in the textbook to generate questions and begin to familiarize yourself with the content that will be discussed in class. A little prep-work can make it a lot easier to follow along with class and figure out where you are confused in time to get helpful feedback.

After class.

We will assign **daily** problems so that you can practice skills and test your understanding of the concepts. The problem sets will be due by the end of the following day. Just like sports and music, it is often important to work together. You are allowed to work on problem sets with other students in the course, with our peer tutors, and with your instructor during office hours. It is important, however, that you write up your solutions on your own – relying too heavily on others might mean that you don't fully understand the problems and don't get enough practice.

How will we be assessed?

Your raw course score will be the best of the following.

35% Daily Problem Sets + 5% Participation + 30% Top 3 Weekly Quizzes + 30% Final
or
35% Daily Problem Sets + + 5% Participation + 40% All Weekly Quizzes + 20% Final

There will also be an optional Application Project wort up to 5% extra. Note, any curve for the course will be set before the extra project in considered, so not doing a project carries no risk.

While there might be a curve that the end of the class, we guarantee <u>at least</u> the following.

Grade range	**A**	**B**	**C**	**D**	**F**
Score	90-100%	80-89.9%	65-79.9%	50-64.9%	0-49.9%

Problem Sets.

Your **daily** problem sets will consist of 3-5 problems and will be do the following day. Each problem is 10 points and there will be a total of 80 problems. To allow for some flexibility, your problem set score will be out of 700 points. This gives you the freedom to submit partial work and to drop 10 problems out of the 80. No extra credit will be given, so 750 points is 100%.

You will earn points for showing your work and explaining your solutions—a correct answer with little or no work may receive little or no credit. The goal is for you to practice what you learn and to get feedback on that practice, so take these opportunities to clearly show what you know. If you have any questions about showing your work, feel free to reach out to your instructor.

Quizzes and the Final

There will be four weekly quizzes and one cumulative final exam in the course. The purpose of these tests is to review and synthesize the material at regular intervals, and to get feedback on your understanding. More details will be provided on the Canvas site.

Optional Application Project

You can work individually or in pairs to complete a project explaining a particular application of the tools we develop in this class. Your project should include real-world data and focus on your ability to describe how linear algebra helps us solve a problem. More details on Canvas.

How do I get support during the semester?

Help with the math content.

Make study groups and come to office hours. If you find yourself really struggling in the course, please reach out to your instructor and we can talk about other support options.

Help with accessibility.

If you have any questions or concerns about accessing course material, reach out to your instructor. The Student Accessibility Services office can help with accommodations related to testing and other services. Also, you should reach out to your college dean with any issues that arise during the semester that might require extensions on assignments and missed content.

Other resources.

- Office of Institutional Equity and Access
- Getting Help at Yale

What is the class schedule?

See the last page…

Book Section(s)	Topics	Day
1.1	Solving linear systems	M, 5/27
1.2	Gaussian elimination	T, 5/28
4.1	Vectors and lines	W, 5/29
4.2	Planes and projections	Th, 5/30
1.3	Homogeneous systems	F, 5/31
1.4, 1.5, 1.6	Applications	M, 6/3
2.1, 2.2	Intro to matrix algebra	T, 6/4
2.2, 2.3	Matrix multiplication	W, 6/5
2.4	Matrix inverses	Th, 6/6
2.4, 2.5	Elementary Matrices and finding inverses	F, 6/7
2.7	LU-factorization	M, 6/10
2.6	Linear transformations	T, 6/11
2.9	Application: Markov chains	W, 6/12
3.1	Determinants	Th, 6/13
3.1, 3.2	Properties of Determinants	F, 6/14
3.3	Diagonalization and eigenvalues	M, 6/17
3.3, 3.4	Application: Linear recurrences	T, 6/18
5.1, 5.2	Subspaces and linear independence	W, 6/19
5.2, 5.4	Dimension and rank	Th, 6/20
5.6	Application: Least squares	F, 6/21
5.3, 8.1	Projections, Gram-Schmidt	M, 6/24
8.1	Orthogonal bases	T, 6/25
8.2	Orthogonal diagonalization	W, 6/26
8.6	Singular Value Decomposition	Th, 6/27
None	Extra, review, or in-class final	F, 6/28