MATH 222E, Course Syllabus

Summer 2025 Session B

Why learn linear algebra?

Linear algebra provides a framework for reasoning about quantities that can be added and scaled. Such structures arise naturally across mathematics, the sciences, and engineering, from balancing forces in physics to modelling supply and demand in economics. Even in nonlinear problems, linearization techniques allow us to extract local behavior and develop effective approximations.

This course extends the familiar theory of linear equations, introducing powerful abstractions that drive modern advances in physics, artificial intelligence, computer graphics, and optimization. Indeed, linear algebra underpins technologies such as Google's search algorithm, ChatGPT's language model, and recommendation systems like those used by Netflix and Spotify. It is essential in financial modeling for pricing assets and managing risk, as well as in medicine for reconstructing images in MRI scans. More than just a set of computational tools, it offers a way of thinking that reveals deep structures, refines predictions, and shapes the technological world around us.

For a perspective on why it is important to learn foundational concepts in linear algebra, check out the the following video: 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, 1:00 - 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. 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 problems after every other class 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. Like most worthwhile human endeavors, mathematics is a collaborative enterprise. You are encouraged to work on problem sets with other students in the course. 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 score for the course will be the best of the following.

1) 35% problem sets + 5% participation + 30% top 3 quizzes + 30% final
2) 35% problem sets + 5% participation + 40% all quizzes + 20% final.

Your course grade will be determined according to your course score:

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

Problem Sets.

Problem sets will be assigned every other meeting of the class, for a total of **12 assignments** of 4-8 problems each. Each problem set will be due at the end of the day of the next class. Individual problems will be worth 10 points and there are a total of 80 problems. To allow for some flexibility your problem set score will be out of 700 points. This gives you freedom to submit partial work and to drop 10 problems out of the 80. No extra credit will be given so 700 points will be the maximum attainable through problem sets.

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 in the course at regular intervals, and to get feedback on your understanding. More details will be provided on the Canvas site.

How do I get support during the semester?

Help with the math content.

Making study groups is encouraged. If you find yourself really struggling in the course, please reach out to your instructor and we can talk about other options for helping you succeed.

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 class 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, 6/30
1.2	Gaussian elimination	T, 7/1
4.1	Vectors and lines	W, 7/2
4.2	Planes and projections	Th, 7/3
1.3	Homogeneous systems	F, 7/4
1.4, 1.5, 1.6	Applications	M, 7/7
2.1, 2.2, 2.3	Matrix Algebra and matrix multiplication	T, 7/8
2.3	Application: shortest path	W, 7/9
2.4	Matrix inverses	Th, 7/10
2.4, 2.5	Elementary matrices and finding inverses	F, 7/11
2.7	LU-factorization	M, 7/14
2.6	Linear transformations	T, 7/15
2.9	Linear transformations application: Markov chains	W, 7/16
3.1	Determinants	Th, 7/18
3.1, 3.2	Properties of Determinants	F, 7/19
3.3	Diagonalization and eigenvalues	M, 7/21
3.3, 3.4	Application: Linear recurrences	T, 7/22
5.1, 5.2	Subspaces and linear independence	W, 7/23
5.2, 5.4	Dimension and rank	Th, 7/24
5.6	Application: Least squares	F, 7/25
8.1	Projections, Gram-Schmidt	M, 7/28
8.1	Orthogonal bases	T, 7/29
8.2	Orthogonal diagonalization	W, 7/30
8.6	Singular Value Decomposition	Th, 7/31
	Final exam	F, 8/1