MATH 228: LINEAR ALGEBRA - FALL 2025

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Class Meetings:	MWF 10am–10:50am, MC 303
Office hours:	MW 3pm–4:30pm; F 11am–12pm; and by appointment

Course information

Course description. Linear algebra is a branch of mathematics that provides a general framework for solving linear systems of equations, describing transformations of space, and understanding the geometry of higher dimensions. It plays a central role in nearly every area of pure and applied mathematics, and has applications ranging from computer graphics and quantum mechanics to machine learning, economics, and cryptography.

The goal of this course is to introduce the fundamental concepts of linear algebra in a way that balances computation with abstract reasoning. The course has three main goals:

(*i*) **Computational Fluency**: You will learn to carry out the core computations of linear algebra, including solving systems of linear equations, manipulating matrices, finding eigenvalues and eigenvectors, and changing bases.

(*ii*) **Abstract Understanding**: You will develop an understanding of abstract vector spaces and linear transformations, in order to explain *why* these computations work. These ideas will lay a foundation for future courses, such as abstract algebra, group theory, and number theory.

(*iii*) **Mathematical Communication**: You will strengthen your ability to read, write, and understand formal mathematical arguments and proofs. These skills are essential for mathematics majors.

Course objectives. By the end of this course, you should be able to:

- Solve systems of linear equations using row reduction and matrix methods, and explain the structure of their solution sets using concepts such as rank, nullity, and subspaces.
- Perform matrix operations, including multiplication, inversion, and computation of determinants, and interpret these operations in terms of abstract linear transformations.
- Understand and apply the concepts of linear independence, span, bases, and dimension.
- Compute eigenvalues and eigenvectors and determine whether a matrix is diagonalisable. Interpret eigenvectors and diagonalisation in terms of abstract linear transformations.
- Understand the role of inner products and orthogonality in defining a notion of distance and angles in abstract vector spaces. (Time permitting)

- Read and interpret mathematical definitions, theorems, and proofs related to linear algebra, and identify common logical structures and proof techniques.
- Construct rigorous proofs of fundamental results in linear algebra, using direct proof, proof by contradiction, and other standard techniques, with clear logical reasoning, precise mathematical language, and good style, exposition, and form.

Course materials. There are no required texts for this course. However, you may find the following textbooks helpful:

- *Linear Algebra*, Stephen Friedberg, Arnold Insel, and Lawrence Spence.
- *Introduction to Linear Algebra*, Gilbert Strang.

These books will be available on course reserve in the library. Another excellent resource is 3Blue1Brown's YouTube course, *Essence of Linear Algebra*.

Course assignments

There will be two kinds of homework assignments:

- Concept check assignments
- Problem sets

In addition, there will be two kinds of optional assignments:

- Extra practice problems
- Bonus problems

Concept check assignments. Most classes, I will assign an online concept check assignment. These assignments are designed to ensure that you have understood the course material, including understanding definitions, and being able to carry out simple computations.

You may complete these assignments as many times as you like before the deadline, and only your highest score will count towards your grade.

You will be asked to complete up to 5 questions, drawn from a larger question pool. In particular, each attempt will consist of a different set of questions. Late submissions will not be accepted.

Problem sets. Each week, I will assign a problem set. These assignments are the main focus of the course. Problem sets typically consist of 3-5 questions, and are designed to challenge you and help you to master the course material.

Since a key objective of this course is to learn to write mathematics, these assignments will be graded both on **mathematical accuracy** and on the **quality of your written communication**.

As the course progresses, we will learn more about what good mathematical writing entails. However, from the start, your homework solutions should be written clearly, legibly, and using appropriate style. In particular, your solutions should be written in full sentences, using proper grammar, punctuation, and spelling. You should use a fresh, clean, standard size paper (or digital equivalent), in portrait orientation, and leave a margin on all sides.

You are expected to write a draft of each of your solutions before writing the final edited form.

Assignments must be submitted electronically. Late homework will not be accepted, except in accordance with the *late homework policy*.

Extra practice problems. After grading homework, if I notice that multiple students struggled with a particular problem, I may assign an optional follow-up problem on a similar theme.

If you choose to complete and submit a solution to this follow-up problem, your score on it will replace your original score, if it's higher. This gives you a chance to reinforce your understanding and potentially improve your grade on topics you found challenging.

To be eligible, you must have made a reasonable attempt on the original problem.

Bonus problems. I will assign occasional bonus problems, which will be more difficult than typical problem sets, and will demand further independent study. These problems are worth extra credit, and they offer you the opportunity to distinguish yourself. Extra credit earned from bonus problems will be added to the problem sets component of your grade.

Assessment

Exams. There will be two in-class midterm exams and a comprehensive final exam:

- First midterm: Wednesday, October 8
- Second midterm: Wednesday, November 5
- Final exam: Friday, December 12, 12pm–2:30pm

Grading. 90% of your grade will be based on the following distribution:

Concept check assignments	10%
Problem sets	30%
Midterm 1	12.5%
Midterm 2	12.5%
Final exam	25%

The remaining 10% will be allocated to the highest of your three exam scores.

In addition, if your grade on the final exam is better than the grade on your lowest midterm exam, then your final exam grade will replace your lowest exam grade. In order to benefit from this policy, you must take all three midterm exams.

You will be assigned a letter grade based on the following scale:

A	A-	B+	B	B-	C+	C	C-	D	F
[93,100]	[90, 93)	[87, 90)	[83, 87)	[80, 83)	[77,80)	[73,77)	[70,73)	[65,70)	[0,65)

In accordance with the policy of the Dean of the Faculty, the grade of A+ is reserved for students who truly excel in the course, and would rate as in the top 1% of Trinity students.

Course policies

Attendance and participation. Unless otherwise announced, all class meetings will occur in person, and you are expected to attend each class. *Regular attendance is vital to success in this course,* and repeated absences will impact your ability to keep up with the course material. While you will not be explicitly graded on attendance, in borderline cases, I may take attendance and participation into account when determining final grades.

If you need to miss a class due to illness, college event, or any other reason, please email ariel.weiss@trincoll.edu to inform me, and I'll do my best to help prevent you from falling behind.

Late homework policy. You have three grace days for problem sets during the semester. A grace day lets you turn in a homework assignment up to 24 hours late for any reason, with no explanation needed. You may use these days one at a time or all at once, but once they are gone, no further late work will be accepted without prior approval.

Beyond these three grace days, late homework will only be accepted if you have a valid excuse (e.g. illness, family emergency) that you communicate to me *before the deadline*, and I approve it. Excused late work of this kind does not count against your grace days.

Collaboration. You are strongly encouraged to work with other members of the class to solve homework questions and to understand the course material. However, *your final write-up must be entirely your own.*

Outside resources. You are strongly encouraged to seek outside resources to improve your understanding of concepts, find additional exercises, and see different perspectives on problems.

However, when doing so, be aware that seeing the solution to a problem is often far less instructive than trying to figure it out on your own. While homework problems may be challenging and require persistence, you will have all the tools you need to solve them. As such, while it may be tempting to consult resources outside of the class to assist with homework problems, it will be best for your learning process to refrain from doing so.

Use of Generative AI. As machine learning tools like ChatGPT become more widespread, it's important to use them thoughtfully and responsibly. The course policy on these tools can be succinctly summarised as follows:

- You are encouraged to use generative AI tools in ways that enhance your learning.
- You should not use generative AI tools in ways that detract from your learning.
- Submitting AI-generated content as your own work is plagiarism and is strictly prohibited.

Examples of uses of AI that are beneficial include generating lists of practice problems, asking for explanations of a concept that you are struggling with, asking for clarification of unfamiliar terminology or reviewing definitions, using AI to help brainstorm questions to ask during office hours or study group sessions, and requesting a worked example of a problem type *after* attempting similar problems yourself.

Note that AI tools may provide information that is wildly incorrect, and that using AI is only beneficial if you are sufficiently sceptical of its output.

Examples of uses of AI that are not beneficial include asking for hints for current homework problems, requesting a worked example of a type of problem *before* you have attempted similar problems yourself, and using generative AI in place of collaborating with your peers.

Examples of uses of AI that reach level of plagiarism include any use of AI that results in you submitting AI-generated material, even if you substantially revise or reword it. This includes copying explanations, computations, or proofs, regardless of how much you edit them.

These categories are necessarily subjective, with many grey areas. If you are in any doubt whether a use case of AI is beneficial, not beneficial, or prohibited, please err on the side of caution and ask me first!

Academic Integrity. Academic honesty is highly valued at Trinity. In accordance with the Trinity College Student Integrity Contract, students are expected to abide by the highest standards of intellectual honesty in all academic exercises. Intellectual honesty assumes that students do their own work and that they credit properly those upon whose work and thought they draw. It is the responsibility of each student to make sure that they are fully aware of what constitutes intellectually honest work in every examination, quiz, paper, laboratory report, homework assignment, or other academic exercise submitted for evaluation in a course at Trinity College.

Academic Accommodations. Trinity College is committed to creating an inclusive and accessible learning environment consistent with the Americans with Disabilities Act. Students with disabilities who may need some accommodation in order to fully participate in this class are urged to contact the Student Accessibility Resource Center, as soon as possible, to explore what arrangements need to be made to assure access.

If you have approval for academic accommodations, please notify me by the end of week two of classes. For those students with accommodations approved after the start of the semester, a minimum of 10 days' notice is required. Please be sure to meet with me privately to discuss implementation.

Student Accessibility Resources can be reached by emailing SARC@trincoll.edu.

Disclaimer. This course syllabus is a general plan for the course, however, deviations may be necessary. If I need to change a course policy, I will make an announcement to the class and give sufficient notice.