California Institute of Technology
Department of Computing + Mathematical Sciences

ACM/IDS 104 Applied Linear Algebra

Fall 2026

Lectures:	Tue & Thu, 10:30–11:50 am, Kerckhoff 125
Instructor:	Konstantin (Kostia) Zuev
Office:	Annenberg 114
Email:	kostia@caltech.edu (please include "104" in the subject line)
Office Hour:	Thu 2–3 pm, or by appointment (please feel free to email me to schedule)
Head TA:	Ethan Feng (efeng@caltech.edu)
TAs and OHs:	https://piazza.com/caltech/fall2026/acm104/staff You are welcome to attend as many office hours as you like.

Course Description

Linear algebra is a branch of mathematics that lies at the heart of applied science and engineering. This is an intermediate linear algebra course aimed at a diverse group of students, including undergraduates in applied mathematics, information and data sciences, and engineering, as well as graduate students in science and engineering. The main goal of the course is to provide an introduction to the fundamental ideas, concepts, and methods of applied linear algebra and illustrate them with important applications. Topics covered include linear systems; PLU factorization; vector spaces and bases; fundamental matrix subspaces; inner products; norms; Cauchy–Schwarz and triangle inequalities; normed spaces; k-means algorithm; positive-definite and Gram matrices; least squares solutions; weighted least squares; polynomial interpolation; orthogonal projections; Gram–Schmidt process; QR factorization; Legendre polynomials; polynomial approximation; eigenvalues, eigenvectors and eigenbases; Gershgorin's theorem; Perron's theorem; PageRank algorithm; power method; diagonalization; symmetric matrices, spectral theorem, optimization interpretation of eigenvalues and eigenvectors; singular values and singular vectors; singular value decomposition; condition number; pseudoinverse; matrix norms; best rank-k approximation; Eckart–Young theorem; and applications to clustering, text classification, data fitting, ranking webpages, principal component analysis, spectral method for graph partitioning, image compression, political science, and facial recognition.

Prerequisites

- Ma 1 abc (enforced prerequisite).
- Some familiarity with MATLAB, e.g. ACM 11, is desired.

Textbooks

- Comprehensive Lecture Notes (will be posted on Piazza after each lecture)
- P.J. Olver & C. Shakiban, *Applied Linear Algebra* (covers ~ 2/3 of the course)
- N. Johnston, *Advanced Linear Algebra*

TA Office Hours

There are two types of TA office hours:

- Q&A: session focused on helping students get started with problem sets.
- Recitation: problem-solving session aimed at developing general problem-solving skills (not related to problem sets).

Practice Problems

Each lecture will be accompanied by two practice problems: a somewhat easier, more practical Problem A, and a more difficult, more conceptual Problem B. The main goal of the practice problems is threefold: to help you better understand the material covered in the corresponding lecture, to help you prepare to solve problems in problem sets and exams, and to accommodate the diversity of students' math backgrounds by providing both easier and more challenging problems. These problems are for self-practice: they will not be graded, and the solutions (posted on Piazza) also illustrate the expected level of rigor for problem sets and exams.

Problem Sets

There will be six Problem Sets. Problems (and solutions) will be posted on Piazza. For assignment and due dates see "Important Dates" below. Late submissions will not be accepted, but the Problem Set with the lowest score will be dropped and not counted toward your total score. Submitting wrong files or files in a wrong format is considered a late submission. Extensions may be granted for academic, personal, or medical reasons. For extensions, please email the Head TA.

Exams

There will be two exams:

1. **Midterm**: based on Lectures 1-8, **take-home**. You can use as much time as you need, but it is designed to take about 2.5h. The Midterm will give you a good idea of the level and style of problems on the Final and should be viewed as practice for it.
2. **Final**: based on Lectures 9-16, **in-person**, 2.5 hours long, paper-based (no electronic devices).

The Head TA will provide a review session before each exam. Both exams are closed-book, but you can use one double-sided sheet of your own notes: only material written or typed by you may be used during exams. Electronic devices may be used only for typing and for arithmetic operations on the Midterm. The Final is paper-based: no electronic devices are permitted.

Grading

Your final grade will be based on your total score. Your total score is a weighted average of Problem Sets (50%), Midterm Exam (10%), and Final Exam (40%). You can increase your total score by up to 5% if you participate actively in Piazza discussions in the Q&A section[1]. Each student answer that is submitted before a TA or the instructor posts an answer, and that is later endorsed as a 'good answer' by a TA or the instructor, adds 1% to your total score. There are no fixed thresholds for grades, but if your total score is 90% (80%, 70%, 60%), then you are guaranteed at least A (B, C, D).

Grade A+

To get an A+, a student needs to become a Candidate for A+ and to pass an **Oral Exam**. To become a Candidate for A+, your total score must be above a certain threshold: the exact threshold will be determined at the end of the term, but it is likely to be around 95%. After the Final Exam is graded, the instructor will email all Candidates and they will have two options: 1) decline the Oral Exam and get an A, 2) participate in the Oral Exam. The Oral Exam involves answering two randomly selected theoretical questions (stating a definition and a theorem from the course) and solving one problem, randomly chosen from problem sets and practice problems. There are two possible outcomes of the Oral Exam: a pass and an A+ final grade, or a fail and an A final grade. The length of the Oral Exam is 15–20 minutes.

Ethical Use of AI

You can use AI tools (e.g., ChatGPT) to support your learning in this course, but only in ethical and responsible ways. For example, it is fine to use AI to generate a practice exam based on the topics covered in the course, to quiz you on course material, or to help with programming syntax or debugging. However, AI should not replace the mathematical thinking you are supposed to do on graded work. For example, using AI to directly solve your problem sets or exams, to give you hints, or to check your solutions for correctness is not allowed, as it undermines your learning and violates Caltech's Honor Code. When in doubt, ask yourself: would this still be considered your own work if a tutor provided this kind of help? If not, then it is also not appropriate to ask an AI to do it. Most importantly, keep in mind that you are here to train your own neural network, not the artificial one.

Collaboration Policy

A detailed collaboration policy is given on the course website at:
http://www.its.caltech.edu/~zuev/teaching/2026Fall/CollaborationACM104.pdf
In general, collaboration is encouraged everywhere except for the exams. Let's help each other and learn together!
If you get stuck on a homework problem, I encourage you to discuss it with other students (offline or online on Piazza). But remember that you will have to prepare and submit your solution by yourself. No collaboration is allowed on the exams.

Important Dates (All times are Pacific Times)

	Available	Due
Problem Set 1	1pm Tue, Oct 06	9pm Tue, Oct 13
Problem Set 2	1pm Tue, Oct 13	9pm Tue, Oct 20
Problem Set 3	1pm Tue, Oct 20	9pm Tue, Oct 27
Head TA Review	10:30am Tue, Oct 27	
Midterm Exam (take-home)	1pm Tue, Oct 27	9pm Tue, Nov 03
Problem Set 4	1pm Tue, Nov 03	9pm Tue, Nov 10
Problem Set 5	1pm Tue, Nov 10	9pm Tue, Nov 17
Problem Set 6	1pm Tue, Nov 17	9pm Tue, Nov 24
Head TA Review	10:30am Tue, Dec 01	
Final Exam (in-person) Location: KRK 125 / ANB 105[2]	Start: 3:30pm Thu, Dec 10	End: 6pm Thu, Dec 10

[1] If you are interested in being a TA next year, try to be active on Piazza and help other students by answering their questions.

[2] Room ANB 105 is reserved for students with CASS accommodations. KRK 125 is reserved for students without CASS accommodations.

Websites

- Course website:
  http://www.its.caltech.edu/~zuev/teaching/2026Fall/ACM104.htm
- Lecture notes, practice problems, problem sets, midterm exam, solutions, announcements, and class discussions will be managed via Piazza, which is designed such that you can get quick help from your classmates, TA(s), and instructor. Instead of emailing questions to the teaching staff, I encourage you to post your questions on Piazza because
  - You will get the answers faster.
  - Your classmates may also benefit from seeing the answers to your questions.
- Here is the Piazza page:
  http://www.piazza.com/caltech/fall2026/acm104/home
- Problem sets and exams will be graded via Gradescope.
  - If you are a **registered student**, you will be enrolled on Gradescope by the end of the 1st week of classes, and you will receive a notification from Gradescope about your enrollment.
    - Please make sure that the email that you use on Gradescope is your official Caltech email.
  - If you are a **registered student** but have not been enrolled on Gradescope by the end of the 1st week of classes, please email the Head TA as soon as possible to get enrolled on Gradescope. Your absence on Gradescope means that, according to my records, you are not registered for the course.
  - If you just want to **audit the course**, it is fine: you will have access to Piazza and all course materials there (please email me and I will enroll you on Piazza), but you will not have access to Gradescope and your submissions will not be graded. If you audit the course this year, you should not register for the course in the future.

  To submit your solution via Gradescope, you need to create a single PDF (not images) that contains the whole solution (for example, by scanning your solution), and then upload it to Gradescope. Here is a useful link:
  - How can I submit my homework as a PDF?
    https://guides.gradescope.com/hc/en-us/articles/21862105254413-How-can-I-submit-my-homework-as-a-PDF

  Should you have any questions regarding Gradescope, please ask on Piazza: we will have many experts there.

Suggested Study Process

To get the most out of ACM 104, here is my suggested study process[3]:

- **Have Enough Sleep**: Good sleep is an important prerequisite for learning.
- **Attend Lectures**: Focus on understanding the big picture of what is going on.
- **Review Lecture Notes**: Ideally on the same day they are released, make sure everything is clear.
- **Ask and Answer Questions**: If something is not clear, ask on Piazza; help your classmates by answering their questions.
- **Summarize in Your Own Notes**: After each lecture, very briefly summarize my notes, extract the essence.
- **Work on Practice Problems**: Attempt to solve the practice problems and review my solutions.
- **Attend Office Hours**: Interact with the instructor, TAs, and other students.
- **Start Early**: Begin each problem set on the day it is released (or as soon as possible after that).
- **Finish Early**: Aim to complete each problem set and the midterm exam at least one day before the deadline.
- **Stuck? Ask for Help**: If you get stuck on a problem set problem, ask for hints on Piazza.

Keep in Mind

My goal is to help you understand and learn the material. Understanding is a creative process that takes time and effort. If you do not understand something, please ask me. If you are struggling to balance the workload, talk to me. If you have any concerns, let me know. Keep in mind that I am here to help.

Honor Code

"No member of the Caltech community shall take unfair advantage of any other member of the Caltech community."

[3] Based on Stanislav Dehaene, *How We Learn: The New Science of Education and the Brain*. 2020: Penguin Books Limited.