Math 201: Linear algebra

Syllabus and course info for Sections F02 and F03

Instructor
Zajj Daugherty (she/her) [How to pronounce my name]
Library 304
zdaugherty@reed.edu

Textbook
Jim Hefferon, Linear Algebra, Fourth edition.
Available free online at either of the following, along with lots of extra resources.
https://joshua.smcvt.edu/linearalgebra/
https://hefferon.net/linearalgebra/

Other reading:

- "Communicating Mathematics through Homework and Exams", Zajj Daugherty https://people.reed.edu/~zdaugherty/teaching/writing_tips.pdf
- "Guidelines for Good Mathematical Writing", Francis Su https://people.reed.edu/~zdaugherty/teaching/Su-Guidelines_for_Good_Mathematical_Writing.pdf
- "The State of Being Stuck", Ben Orlin https://mathwithbaddrawings.com/2017/09/20/the-state-of-being-stuck/
- "Avoiding Plagiarism in Mathematics", Richard Neidinger https://people.reed.edu/~zdaugherty/teaching/plagiarism.pdf

Office hours
(Subject to change depending on how these go)
Zajj: Tuesday 3-4 pm, Thursday 9:15-10:15 am, or by appointment. Lib 304.
Liam (course assistant for 201): Wednesday 4:15-6:15, Lib 204.

Why come to office hours?
It's a great time to dive further into the material, clean up nagging confusions, and get to know each other better. It's helpful if you come with specific questions, but they're not required. Sometimes office hours are just for review, or doing examples, or talking about other resources that can help enrich your time in this class. But if you're just not used to going to office hours for your classes, then that alone is probably the *best* reason to come and check them out!

Additional help
There will be tutoring sessions both at the math help center and with our course assistant (probably Wednesdays, but still pending). The math help center is open SMTuTh from 7-9pm in Lib 204. You also have access to individual tutors.

Slack signup:
https://join.slack.com/t/math201fall22sec0203/shared_invite/zt-1emd01m7b-R_E7v03Fkw5R2Vn35lcrsg

Last edited: *Sep 7, 2022*

About this course

Course description

This class is about the algebraic theory of finite dimensional vector spaces. Topics include linear transformations, determinants, eigenvalues, eigenvectors, and diagonalization. Geometry of inner product spaces is examined in the setting of real and complex fields.

Learning outcomes.

After actively and thoughtfully engaging in this course, I'm confident students will be able to do the following.

- Solve systems of linear equations.
- Define vector space, basis, dimension.
- Express linear transformations as matrices and vice versa.
- Compute determinants and describe their universal and geometric properties.
- Compute eigenvalues and eigenvectors of linear transformations, and describe their meaning and use.
- Describe the geometry of inner product spaces.
- Prove results and solve open-ended problems related to the above topics.
- Apply the above topics in relevant examples and applications.
- Communicate mathematical ideas verbally and in writing.

Distribution requirements

This course can be used towards your Group III, "Natural, Mathematical, and Psychological Science," requirement. It accomplishes the following goals for the group:

- Use and evaluate quantitative data or modeling, or use logical/mathematical reasoning to evaluate, test, or prove statements.
- Given a problem or question, formulate a hypothesis or conjecture, and design an experiment, collect data or use mathematical reasoning to test or validate it.

This course does not satisfy the "primary data collection and analysis" requirement.

Course format and COVID

This is an in-person class, and your presence and participation are expected when you are able. In order to help protect the health of and grant access for our whole community, **please wear a mask while in class and office hours**. If you have a medical issue that will make this challenging for you, please see me and Disability and Accessibility Resources to discuss accommodations.

Further, if you find yourself sick (not just with COVID) or test positive for COVID-19, please check in with me on Slack or by email, and then *stay home*. Each community member has an individual responsibility to help protect each other's health and wellness through conscientious behavior. For my part, I will make a good faith effort to help meet reasonable accommodations for anyone who must miss class and is communicative.

Accommodations

If you have a documented disability requiring accommodations, please register your course needs for the semester as soon as possible with DAR (Disability & Accessibility Resources). In particular, getting those in early gives us time to touch base about your needs in the specific contexts of this class. I cannot provide accommodations after an assignment has been turned in; I will also need at least 48 hours notice for exams or major projects (except in extreme circumstances, e.g. establishing newly documented accommodations with DAR). If you have an undocumented disability, there's help here at Reed with navigating diagnosis, etc.—Please reach out to DAR, or let me know if you need help with that process.

Evaluation

You will be evaluated based on a combination of your work on exams, weekly homework assignments, weekly summaries, participation, and an end-of-semester project.

Exams

We will have three take-home, time-limited exams—two midterms and one final. Exams may be hand-written, and will be due on Gradescope. Guidelines for what resources you're allowed to use or not will be spelled out on the exams.
Mid 1: Out 9/29, in 10/2. **Mid 2:** Out 11/3, in 11/6.

Projects

At the end of the semester, you will have two projects:

- Weekly summaries. You will be asked to polish your weekly summaries documents, and cap it with a couple small sections reflecting on the semester. More details to come later.
- Presentations. The last week of class will be dedicated to presentations on applications of linear algebra. More details to come later.

Weekly log entries

Each week (Week 2 and on), you will be asked to turn in a running log of the topics covered in class as follows:

- At the end of week *n*, you will discuss the material covered in class with a classmate or two.
- By the beginning of class on Tuesday of week n+1, you will turn in an updated log with a very brief summary of the key points covered in week n. We will begin class Tuesday of week n+1 by discussing these. (Because of this time-sensitive component, *extensions will not be granted week-to-week*, though I will also look holistically at the final document at the end of the semester.) **Aim for 2-ish key points per class meeting.**
- Then, you will flesh out your summary of week n with a little more annotation that may be helpful to your future self. For example, you might fill out a definition, give a full theorem statement, give an important example or two, give citations that will help you find sources of information later (e.g. Section II, Theorem 1.5). Annotations to week n are due in your updated file turned in week n+2. Aim to average between ½ and 1 page per week, depending on your use of diagrams/displayed equations/pictures/etc.

You must work with at least 6 other people over the course of the semester, but you will get extra credit if you write log entries with at least 12 other people (you are welcome to work with people in the other section as well if you like). Your log must be written in LaTeX—I will post a sample template on Moodle that you are welcome/encouraged to use.

Homework

Weekly homework assignments will be due Fridays by 11:59pm through Gradescope, the week following the material being covered. Exercises will be graded based on completion, validity, and readability/fluency. Homework assignments must be typed in LaTeX (some flexibility will be given for "good-faith" attempts to use LaTeX as you learn). I will provide the .tex source code of your assignments, and you are strongly encouraged to start with those files. See Moodle for more help with LaTeX.

Late or missing assignments
In order to receive full credit, assignments must generally be turned in on time. Sometimes things happen, though. If you need an extension on a weekly homework assignment, check in with me ahead of time, and I will grant up to two extensions (of two days) without much fuss. I will also drop your lowest non-zero assignment—even if things are tight, it's good practice to turn in *something.* As with everything, communication is key.

Collaboration versus plagiarism
You are welcome and strongly encouraged to work with your classmates on homework, and to ask questions liberally in class, on Slack, or at tutoring sessions. However
(1) do not exchange written complete solutions (especially .tex code thereof); and
(2) plagiarism or uncited sourcing of anyone else's work (classmates, online solutions, tutoring services, etc.) is strictly prohibited.
Suggested reading:
Richard Neidinger's "Avoiding Plagiarism in Mathematics":
https://people.reed.edu/~zdaugherty/teaching/plagiarism.pdf

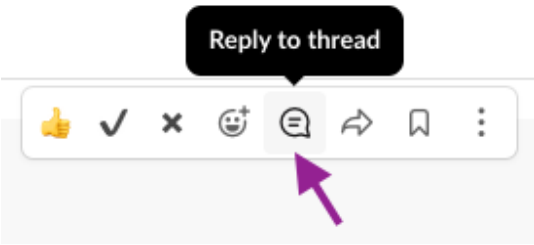
Practice exercises
Associated to each class meeting, I'll give a list of "practice exercises" straight from the book. These are never due–they're totally for your own practice, and solutions are available on the course website. There will be some overlap with the *types* of problems you'll be asked on the homework, and you are responsible for being able to *do* problems both on the homework and from the practice problems when it comes time to do exams. Think of it like this: The homework, the practice problems, and the solutions are all tools for your learning—use them wisely.

Participation & Attendance
You are expected to attend class when you are able, and are expected to participate in class and in the Slack workspace. If you must miss class, contact me letting me know (no details needed unless you must miss more than 3 classes).

Slack code of conduct
The Slack workspace is an extension of our classroom—we should aim to make it a safe, respectful, and active place to learn and grow mathematically.

- Participate! Aim to contribute with questions, collaboration, or in other mathematically relevant ways at *least* once every other week.
- Be curious, generous, and respectful! Ask questions, add to questions, answer questions, help others hone questions and answers. Challenge yourself to be brave when you're confused, and encouraging when you're not.
- Be ethical! Never post full solutions and never ask questions about exams until cleared to do so (remember that even after an exam is due, there may be special circumstances that lead to not all exams having been turned in yet). Exceptions: You may always message me privately with solutions that you have questions about, or to ask questions about exams or anything else about class. If in doubt, start with a direct message—if you ask me a question privately that turns out to be something that's good to post to everyone, I'll copy it to one of the channels and answer it there.

- Be patient! Everyone sleeps (especially old people like your professor) and everyone has stuff going on that's not Linear Algebra related. For me, that means that sometimes I'll pop on at odd hours and answer a question, but generally please allow for a one-business-day lead time.
- Be organized! Please use **"Reply to thread"** when responding to someone's post (including your own). The channel #announcements is just for me to post in, but you're welcome to reply to threads there too (just don't make your own top-level posts in that channel).



General tips for succeeding our class

Here's the most important thing for you to know about me as a professor: It is *very* important to me that I help you to access the best education possible during our time together. To that end, I will push you to face real mathematical challenges, but I will also work very hard to support you. This time of learning during a global pandemic poses extra challenges and draws on both your and my time and energy. But if you continue to strive to do your best, then I will too.

To that end:

- Communicate, communicate, communicate---Write emails, use Slack, ask questions in class. If you're confused, lost, swamped, or whatever, say so. Even if you don't know what questions to ask, let me know you're missing something, and I will try to get you back on track.
- Budget your time—try to set a schedule for yourself of when you're going to work on this class. There are *lots* of resources, but you can only make good use of them if you make the time and stay ahead of the deadlines.
- Be respectful—of me, of your classmates, and of yourself.
- Get to know me and your classmates professionally. Math is best as a collaborative experience, and your classmates are some of your best resources. Talk to each other, work together, explain things and ask questions.
- Be honest and work with integrity; if you slip up, come talk to me and we'll work out a fair way to proceed.
- Have fun! Linear algebra can be challenging, but it's also a really fun topic. Learn to play with the ideas: do examples, make hypotheses, and prove results by explaining why things are true with precision and style.

Approximate schedule

This is a rough version of the weekly schedule for topics covered in this class.

1. Solving systems of linear equations, reduced echelon form, geometry of vectors in R^2 and R^3.
2. Vector spaces, subspaces, linear combinations, spans, linear independence.
3. Basis and dimension.
4. Row space and column space, linear transformations.
5. Range and null space, dimension theorem, matrices representing linear transformations.
6. Operations on linear transformations and operations on matrices.
7. Inverse of a matrix, elementary matrices,.
8. Change of basis, Determinants.
9. Eigenvalues and eigenvectors.
10. Eigenpaces, diagonalizability, Jordan canonical form.
11. Inner products, Gram-Schmidt orthogonalization.
12. - 13. Orthogonal complement, orthogonal projection, least squares approximation, spectral theorem.
13. - 14. Presentations.