Syllabus
Math 354 - Honors Linear Algebra
Spring 2023

Instructor:
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Course Information:
Course meets: MWF 1-1:50pm in Herman Brown 227
Office Hours: Mondays 2pm-2:30pm, Wednesdays 2pm-2:30pm, Thursdays 2:30pm-3:30pm in my office, or by appointment
Course Webpage: Math 354 001 F23 on Canvas
Teaching Assistant: TBA
Recitations: Tuesdays 7-8pm (to be confirmed)

Prerequisites: A 200-level Math course is recommended. Some exposure to linear algebra at the level of Math 211 or 221/222 is recommended, though not necessary. The only real prerequisite is a willingness to think hard about abstract mathematics, and to spend time grappling with ideas that will change your life. Talk to me in person if you are unsure whether you are ready to take this class.

Textbook: We will be using the **fourth edition** (currently only in electronic form) of *Linear Algebra Done Right* by Sheldon Axler. This edition is set to be published in Fall 2023. We have been given the chance to class test this book (along with 20+ other universities); in return you will get an electronic version of the book via Canvas. It is very important that you do not distribute this preliminary copy of the fourth edition online or to friends. Once this version is published, it will an Open Access book, meaning that the electronic version will be available free to the world. The third edition of LADR (ISBN: 978-3-319-11079-0) is similar to the current version, if you want to also have a physical copy. The differences between the two versions can be found on page xvi in the fourth edition.

Videos: Professor Axler has recorded 50 videos to accompany the book. I highly receommend watchin these before class especially if you are having a difficult time. We will use these to complement the lectures: `https://linear.axler.net/LADRvideos.html`. Students who have a hearing disability or who want to see captions can click the CC button near the bottom of each video to turn on captions. The default language of the captions is English, but many other languages can be chosen from the settings menu next to the CC button (click "Subtitles" then "Auto-translate" and then select a language)."

Homework: All homework and reading assignments can be found on Canvas. The homework will be due once a week, on **Friday by 11:59pm CST/CDT** via Gradescope. No physical homework will be accepted. Late homework will not be accepted, instead your lowest homework score will be dropped.

The homework is not pledged and you can collaborate with other students in the class. In fact, I would highly *encourage* to do so! However, you are not allowed to look up solutions in any written form; in particular, *you are not allowed to look up solutions in either print or electronic format.* Students caught violating this rule will be reported to the Honor Council. You must write up your solutions individually.

Homework is an extremely important part of the course! This class has a heavy workload, and you should expect to spend a lot of time doing homework (10 hours per week on average, outside of the classroom).

Exams: There will be two midterm exams, on **Thursday, February 16** and on **Thursday, March 30**. These exams will take place 7:00–9:00pm in a location to be determined. If you have a conflict with these times, let me know about it in the first two weeks of classes. There will also be a written, 3-hourfinal exam. All exams are pledged and subject to the Rice University Honor Code.

Important: The date for the final exam is not available at this time. It is the policy of the Mathematics Department that no final may be given early to accomodate student travel plans. If you make travel plans that later turn out to conflict with the scheduled exam, then it is your responsibility to either reschedule your travel plans or take a zero in the final.

If an exam conflicts with a holiday you observe, please let me know.

Grades: Your grade will be based on your homework, midterm exams, and final exam as follows:

- Homework: 30%

- Midterm exam 1: 20%

- Midterm exam 2: 20 %

- Final exam: 30%

This course is not curved, i.e., you are not competing with one another. This aside, at the end of the semester your overall numerical grade will translate into a letter grade as follows:

- 90 are guaranteed to receive an A+/A/A-

- 80 are guaranteed to receive a B+/B/B- or higher

- 70 are guaranteed to receive a C+/C/C- or higher

I reserve the right to lower these numbers (I will not raise them) by the end of the class if needed. For example, I may decide that everyone above 88 percent (instead of 90) will recieve at least an A-.

Attendance: Attendance is not required but I highly encourage you to attend all lectures. You are responsible for all the material and announcements covered in lecture. While Canvas is a valuable resource, not all announcements will be posted there. You are responsible for reading any emails I send to the class through Canvas.

Expectations: In my experience as a student, most people do not follow all the details of a class in real time. When you go to a Math lecture you should expect to witness the big picture of what's going on. You should pay attention to the lecturer's advice on what is important and what isn't. I expect you to go home and fill in the gaps in your understanding.

We will cover most of Chapters 1–8 of Axler's book on "Linear Algebra Done Right", supplemented by some applications to show you the power of linear algebra in the real world, e.g., Google's PageRank algorithm, image compression algorithm, and facial recohnition.

1. **Vector Spaces and linear maps:** Definitions and basic properties.; linear independence, span, bases, dimension. Rank-nullity theorem. Quotient spaces and duality.

2. **Subspaces and eigenvalues:** Invariant subspaces and existence of eigenvalues.

3. **Inner product spaces:** Orthonormal bases and the Gram-Schmidt algorithm.

4. **The Spectral Theorem:** Orthonormal bases of eigenvectors. Singular Value Decomposition.

5. **Minimal + characteristic polynomials:** Generalized eigenvectors; Jordan canonical form.

6. (Time permiting) **Trace and Determinant:** Basics and properties.

7. **Applications:** Google PageRank, image compression, facial recognition.

Course objectives and learning outcomes:. At the end of this course you should be able to do the following.

1. Be able to follow and produce a clearly written mathematical proof, including proofs by application of definitions, by induction, by contradiction, by contrapositive, etc.

2. Be familiar with the core concepts of abstract linear algebra, including vector spaces, linear transformations, duality, invariant subspaces, eigenvalues, eigenvectors, inner product spaces, orthogonality, self-adjoint, normal, and positive operators, characteristic and minimal polynomials.

3. Be able to state, understand, and apply structural theorems from abstract linear algebra to solve problems of a theoretical nature. Some examples of this are invertibility criteria, diagonalizability criteria and direct sum decompositions, Gram-Schmidt orthonormalization, and the Spectral Theorem.

4. Understand how abstract linear algebra some applications of linear algebra to real world applications, such as facial recognition, Google page rank, and image compression.

Discussion: The material in this course can be abstract at times, as well as confusing. These are natural feelings, but they can be seriously amplified by isolation. In order to help each other out, we will be using the discussion platform in Canvas. Participation in Discussion is expected. The first thing you should do is go to the Discussion tab and reply to the `Introductions` thread. I encourage you to introduce yourself there.

Communication Plan: You are welcome to get in touch by email (e.g., requests for disability related accommodations) but that is probably the least efficient way to contact me because of the large numbers of emails I get each day. I am requesting that you ask most of your questions (about logistics, course content, homemwork problems, etc) get asked in the Discussion board on Canvas. The TA and I will be monitor Canvas frequently and will answer questions, or endorse answers by other students, as quickly as I can.

Statement of Conduct: The Department of Mathematics supports an inclusive learning environment where diversity and individual differences are understood, respected, and recognized as a source of strength. Racism, discrimination, harassment, and bullying will not be tolerated. We expect all participants in mathematics courses (students and faculty alike) to treat each other with courtesy and respect, and to adhere to the mathematics department standards of collegiality, respect, and sensitivity:

> `mathweb.rice.edu/department-statement-collegiality-respect-and-sensitivity`

as well as the Rice Student Code of Conduct. If you think you have experienced or witnessed unprofessional or antagonistic behavior, then the matter should be brought to the attention of the instructor and/or department chair. The Ombudsperson is also available as an intermediate, informal option, and contacting them will not necessarily trigger a formal inquiry. See the above website for details on how to contact the Ombudsperson.

Title IX Statement: Rice University cares about your wellbeing and safety. Rice encourages any student who has experienced an incident of harassment, pregnancy discrimination or gender discrimination or relationship, sexual, or other forms interpersonal violence to seek support through The SAFE Office. Students should be aware when seeking support on campus that most employees, including myself, as the instructor, are required by Title IX to disclose all incidents of non-consensual interpersonal behaviors to Title IX professionals on campus who can act to support that student and meet their needs. For more information, please visit `safe.rice.edu` or email `titleixsupport@rice.edu`.

Disability Support: If you have a documented disability that may affect academic performance, you should: (1) make sure this documentation is on file with Disability Resource Center to determine the accommodations you need; and (2) get in touch with me to during the first two weeks of class to discuss your accommodation needs. All such discussions will remain as confidential as possible.