Syllabus
Math 354 - Honors Linear Algebra
Spring 2020

Instructor:
Professor Shelly Harvey
Office: Herman Brown 446
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Course Information:
Course meets: MWF 1-1:50pm in GBR W211
Office Hours: Wednesday 2pm-3pm, Thursdays 2:30pm-3:30pm in my office
Class Webpage: Math 354 001 F20 on Canvas
Teaching Assistant: Stephen Wolff (Stephen.Wolff@rice.edu)
Recitations: TBA

Prerequisites: A 200-level Math course is recommended. Some exposure to linear algebra at the level of Math 211 or 221/222 is strongly recommended, though notnecessary (Math 221 and 354 can be taken concurrently and they complement each other well). 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: *Linear Algebra Done Right* (Third edition) by Sheldon Axler, Undergraduate Texts in Mathematics, Springer, New York 2015. ISBN: 978-3-319-11079-0.

Videos: Professor Axler has recorded videos to accompany the book. We will use these to complement the lectures: `http://www.linear.axler.net/LADRvideos.html`

Homework: All homework and reading assignments can be found on Canvas. The homework will be due once a week, on **Friday, between 4pm and 5pm** in my office. You can also turn the homeworks at the beginning of lecture. Please do not turn in the homework during the lecture. 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.

Exams: There will be two midterm exams, on **Wednesday, February 19** and on **Wednesday, April 1**. 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%

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.

Disability Support: Any student with a documented disability seeking academic adjustments or accommodations is requested to speak with me during the first two weeks of class. All such discussions will remain as confidential as possible. Students with disabilities will need to also contact Disability Resource Center in the Allen Center, Room 111.

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, the Spectral Theorem, and Jordan block decompositions.
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.