Linear Algebra II (Math 469)

Spring 2020

Technicalities

Instructor: Dr. Clayton Shonkwiler (clay@shonkwiler.org)
Office: Weber 206C
Course web page: https://www.math.colostate.edu/~clayton/teaching/m469s20/
Text: *Linear Algebra Done Right*, by Sheldon Axler, which is available for free at https://doi.org/10.1007/978-3-319-11080-6 from any on-campus computer.
Time/Location: 1:00–1:50 MWF, Weber 223.
Office Hours: Wednesday 2:00–3:00 and Thursday 1:00–2:00.

Course Content

Part I: Basic Theory – 6 weeks

- (Axler Chapter 1) Fields of real and complex numbers, vector spaces, uniqueness, subspaces, sums and direct sums.
- (Axler Chapter 2) Linear combinations, span, linear independence, bases, and dimension.
- (Axler Chapter 3) Linear maps, spaces of linear maps, null spaces, injectivity and surjectivity, matrices, invertibility, products of vector spaces, quotients of vector spaces, dual spaces, rank.
- (Axler Chapter 5) Invariant subspaces, eigenvalues and eigenvectors, existence, diagonalizability.
- **Midterm 1**: Feb. 28–Mar. 6.

Part II: Applications and Generalizations – 7 weeks

- (Axler Chapter 6) Inner product spaces, norms, orthonormal bases, orthogonal complements, optimization.
- (Axler Chapter 7) Operators, adjoints, the spectral theorem, positivity, polar decomposition, singular value decomposition.
- (Axler Chapter 8) Generalized eigenvectors, nilpotent operators, operator decompositions, characteristic and minimal polynomials, Cayley–Hamilton Theorem, Jordan normal form.
- (Axler Chapter 9) Complexification, minimal polynomials and eigenvalues of complexifications, operators on real inner product spaces.
- **Midterm 2**: Nov. 22–Dec. 6.

Part III: Trace and Determinant (Finally!) – 2 weeks

- (Axler Chapter 10) Trace, operators and matrices, determinant, sign issues, volumes, multilinear algebra.

Prerequisites

Though not prerequisites, we will be studying linear algebra from an abstract point of view, so it will be helpful to have some background in algebra (e.g., MATH 366), and we will be connecting to

the geometry of multivariable calculus, so it will also be helpful to have some background in that (e.g., MATH 261). Students without any experience in proof-based courses (e.g., MATH 317 or MATH 366) may struggle.

Course Goals

Develop a deep understanding of the structure of linear operators on finite-dimensional vector spaces.

Assignments

It is impossible to *learn* mathematics without actually *doing* mathematics. The goal of the assignments is to deepen your understanding of the concepts, tools and techniques discussed in class, as well as to give you the opportunity to practice explaining your mathematical thinking. The importance of effective communication is vital: knowledge without the ability to communicate that knowledge is of limited value. As such, to get full credit on a problem your solution must be clear and well-written.

Reading Assignments

You will be assigned to read relevant sections from the text before the material is discussed in class. Although it is impossible (at least absent some pretty intrusive surveillance) to check whether you are doing this reading, you will also be expected to do a short online reading comprehension quiz on Canvas for each reading assignment. This quiz will not be graded for correctness, only for whether you made an honest attempt at each problem.

Homework

Homework will be collected every week or so.

Homework must be stapled with your name clearly written at the top. What you turn in should be a final copy: it should be neat, legible, and well-organized. If I can't read or understand your work you won't receive any credit.

Late homework will not be accepted, so you should turn in whatever you have completed on the due date in order to get credit for it.

I strongly encourage you to work on solving homework problems with your fellow classmates. However, the work you turn in must reflect your own knowledge and understanding and not that of anyone else. Therefore, you *must* write up your solutions by yourself.

Exams

There will two take-home midterm exams. You will have approximately 1 week to do each of the take-home midterms; the first will be due on **March 6** and the second on **May 1**.

No make-up examinations will be given in the course.

Final Project

As a final project, you will create a poster for the math department poster session. The poster session will be held on **Thursday, May 7**. A list of potential project ideas will be circulated; you are also very welcome to develop your own. The following are deadlines for various milestones along the way:

Feb. 28: Project topic
Mar. 27: Two-page project description
Apr. 17: Poster rough draft
May 7: Poster final draft

You should work in groups of 2–3 people.

Attendance

You are expected to attend class every day, to participate in class, to read the textbook, and to do the homework.

Grading

Your final grade in the course will be determined by:

Homework and Class Participation: 40%
Exams: 40%
Final Project: 20%

Here's how the grading process works. First, I compute an overall course grade for you on a scale of 0–100 by combining your exam and homework grades using the weights above. Then, I rank everybody in the class in order by their score and assign cutoffs for 'A', 'B', 'C', and 'D'. Generally these are somewhat lower than the traditional 90, 80, 70, and 60. When setting the cutoff I consider the students immediately above and below the line and try to take into account improvement and other circumstances. That being said, the list is never, ever reordered. Regardless of other circumstances, a better score in the class should always earn at least as good a letter grade. Ultimately, I can only grade the course based on what you have actually done.

Policies

The Department of Mathematics has a set of policies which cover topics ranging from cell phones to alternate exams. These are available at
https://mathematics.colostate.edu/undergraduate-students/departmental-class-policies/
and it is your responsibility to read them.

Some particular issues of interest:

Academic honesty

Colorado State University has an Academic Integrity Policy and Student Conduct Code; you can read about this policy at http://policylibrary.colostate.edu/policy.aspx?id=442, and find related materials at https://tilt.colostate.edu/Undergrad. This will be enforced in Math 469. Briefly, while you are encouraged to seek out help, including from your peers, for homework assignments, all work on any exam must be your own.

Students judged to have engaged in cheating on an exam will receive a score of 0 for that particular exam. Also, for the student who received a 0 on an exam due to cheating, Repeat/Delete will not be an option for the grade earned the semester cheating occurred. A second offense will result in an F for the course. Cases of flagrant academic dishonesty will be brought to the attention of the TILT Academic Integrity Program.

SDC

Colorado State University is committed to providing reasonable accommodations for all individuals with disabilities; the Student Disability Center (https://disabilitycenter.colostate.edu) coordinates the necessary support systems.

If you need accommodation, especially for exams, it is up to you to work with SDC to make suitable arrangements; the sooner you do this, the better.

Additional help

If I were a perfect teacher, you could learn everything you need to know just by going to class and doing the assignments. Unfortunately, I am not a perfect teacher, so there's a good chance that, at some point, you'll find yourself confused, stuck or otherwise frustrated by the material or the course. If you do, ask for help! Come to office hours, send me email, ask me questions after class.

Also, your fellow classmates are a great resource! Odds are that, for any question you have, there's someone in the class who can answer it, so don't be afraid to ask. Even the simple process of explaining why you're stuck to someone who is just as confused as you is often enough to make things clearer. Just be sure to return the favor when you get the chance to help someone else.

If you need additional help or outside resources, please ask and I will be happy to try to give suggestions.

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Disclaimer

The course syllabus is a general plan for the course; deviations announced in class may be necessary.