MAT-150: Linear Algebra, Fall 2022

Section B: TR 9:40-10:55 AM

Most days: CHAM 2084

Instructor: Claire Merriman

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Office: Chambers 3043

Office Hours: M 11:00 AM-12:00 PM, MW 2-3 PM, R 3:30-4:30 PM

Embedded Tutor: Delario Nance

Email: denance@davidson.edu

Location: Chambers 2234

Office Hours: T 7:00-9:30 PM Saturday 1:30-4:00 PM

Course Grades:

Preparation Assignments	5%
In Class Activities	5%
Homework	10%
Mathematica Labs	10%
Reviews	70%

Grading Scale:

A	93-100	A-	90-92		
B+	87-89	B	83-86	B-	80-82
C+	77-79	C	73-76	C-	70-72
D+	67-69	D	60-66	F	0-59

Lab Dates (in LIB B110)

September 8, September 15, September 29, October 13, October 20, November 10, December 8

Review Dates:

September 27: Review 1

October 25: Review 2

November 15: Review 3

December 6: Review 4

December 12-16: Self Scheduled Final Review

Course Information

Algebra is the mathematics of relationships; linear algebra is the study of those relationships which 'behave like lines'. This course supplies a foundation in matrix theory and related topics from three perspectives: abstract algebraic, computational, and geometric. To this end, we will supplement instruction with Mathematica labs, a very powerful software tool with the capability of solving many linear algebra problems.

A student who is successful in this course will have developed both their mathematical intuition and Mathematica familiarity, and subsequently be able to formulate and solve problems in both mathematical and applied contexts. In particular, the successful student will develop as an independent learner and problem solver with the ability to approach problems from a conceptual viewpoint, utilize more than one idea in a single problem, and apply appropriate linear algebra skills to problems in context.

Textbook and Software

Textbook: *Linear Algebra and Its Applications, 5th edition* by D. C. Lay, S. R. Lay, J. J. McDonald Pearson, 2016. (A PDF of this text, supplied by our library, can be found on Moodle.)

Software: We will be using Mathematica this semester. It is pre-installed on the computers in our lab. If you'd like to download a copy on your personal computer, here are the steps, but keep in mind that Mathematica is a very large program.

Online Homework Submission: All assignments will be submitted on Gradescope. You will also find your grades and feedback on assignments on Gradescope. To get started, follow the invite link to create an account on Gradescope using your Davidson College email address or join our course using the code Y77GNR.

Learning Outcomes

Upon successful completion of the course, students will be able to:

- Apply Gaussian elimination and interpret the resulting matrix and describe the solution set to a system of linear equations.
- State, interpret, and apply key definitions and theorems, including: the Invertible Matrix Theorem, the Rank and Nullity Theorem, vector subspace, linear independence, spanning, basis, dimension, the four fundamental subspaces of a matrix, linear transformation, matrix of a linear transformation, and determinant.
- Use properties and results of matrix algebra, vector spaces, and linear transformations to construct short (two- or three-step) proofs of statements in abstract settings.
- Compute eigenvalues and eigenvectors and diagonalize matrices.
- Compute and characterize the behavior of repeated multiplication of a state vector by a matrix (Markov chain or dynamical system) using eigenvector analysis.
- Apply orthogonality and projections to solve geometric or algebraic problems, including Gram-Schmidt orthogonalization and least squares solutions.
- State, interpret, and apply theorems about matrix factorizations

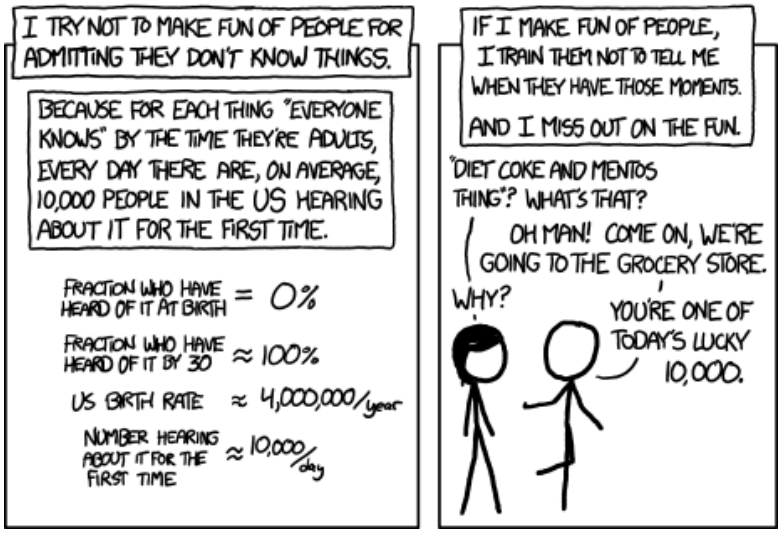
Classroom Expectations

Learning mathematics requires you *do* mathematics. This means that you will spend part of class working on math problems, and you will have times that you struggle to solve them. The goal is for this to be a *productive struggle*, where you emerge with a greater understanding of the concepts.

It is also important that you come to class on time having completed the preparation assignment for the day and stay until the end of class.

I expect this course to be a place where you will be treated with respect. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.

The topics in this course may also be more or less familiar depending on what other courses you have taken. If you have already seen a concept that we cover in class, view this as an opportunity to learn about it from a different perspective and practice explaining math to others.



Conduct violating the Student Handbook, including Honor Code violations and discrimination or harassment based on race, color, national origin, religion, gender, orientation, age or disability will not be tolerated. Contributing to a hostile classroom environment may result in lost points on In Class Activities.

Assignment Descriptions

Preparation

You will have short assignments due before the start of each class to get familiar with the topics we will cover in class. Sometimes these questions will be short calculations, but they will often ask you to explain steps in the examples given in the textbook. These questions will be graded on a mix of completion and accuracy with the following rubrics:

0 points: Missing or minimal effort, such as only writing down the problem or a definition.
1 point: Contains a reasonable attempt to answer at least one question with significant mathematical errors or omissions (such as only answering one of two questions).
2 points: Contains a reasonable attempt to answer all questions with some mathematical errors.
3 points: Answers to all questions demonstrate understanding of the mathematical concepts, possibly with some minor errors.

Preparation assignments for the week will be available on the preceding Saturday. These assignments have a soft deadline of 8:40 am the day of class and will **not be accepted more than 5 minutes after the start of class**. I will do my best to grade any assignments submitted by the soft deadline before the start of class and use the answers to adjust the lecture for the day. Class will start by going over the answers to these questions.

The lowest 2 grades will be dropped.

In class activities

You will have problems to work on in groups throughout class time. These will range from calculation problems that check for understanding to more in-depth problems that benefit from group discussion. I will provide paper copies at the start of each class and collect them at the end of class. We may also do some other activities throughout class.

I will only grade one submission per group, so you should all work together. These problems typically require some amount of discussion. Often homework problems are continuations of the group questions.

In class activities are primarily graded on completion. These are an opportunity for feedback before homework.

Lowest 3 grades will be dropped.

Homework

Weekly homework assignments will cover the material from the past week's lecture, in class activities, and preparation assignments. You are encouraged to work together on the problems; however, you must write up your own solutions and submit them individually.

All homework assignments must have a correctly completed **Homework Cover Sheet**, found in the General Course Materials section of Moodle.

Homework is due on Gradescope by the beginning of class on Thursdays. Late homework assignments we receive a 20 percentage-point penalty per day, unless you are using one of your late passes or I have granted an extension before the assignment is due. You may not use more than one late pass per assignment.

Assignments should be legible–you should work out problems then write up a new, final version. Homework should be on a separate page or in a separate file from you course notes. Problems or assignments that are messy may result in lower grades.

Mathematica Labs

There are seven Mathematica Labs throughout the course. These labs provide an opportunity to explore linear algebra concepts in greater depth. There are several textbook sections on applications that will be covered on Labs but not homework or reviews. These sections are: §1.6 Applications of Linear Systems, §2.7 Applications to Computer Graphics, §4.9 Applications to Markov Chains, and §7.4 Singular Value Decomposition with §7.5 Applications to Image Processing and Statistics.

You will work with a partner and submit one copy of the lab. Both partners should be involved and able to explain all parts of the document you submit. Let me know privately if there is a problem in your partnership.

You may rewrite up to four of your homework and lab assignments. See homework section above for rewrite policies.

Reviews

We will use a standards-based grading system for the reviews. There are 22 *standards* in the course. Your review grade is based on how the number of standards where you have **Demonstrated Understanding**. Each problem will receive on of the following letter scores:

- **U** for Understanding: Your work demonstrates understanding of the key concepts. Solution would be a useful example of a good solution for future students.
- **P** for Progressing: Your work shows partial understanding of the material, but it has significant gaps or errors.

- **N** for Needs Improvement: Your work shows some of the ideas needed for the problem, but does not yet show understanding of the key concepts.
- **X** for Not assessable: It is not possible to assess whether or not your work shows understanding. Normally this is a question that is left blank and you have not previously demonstrated understanding on a previous review. Rarely, this will be for solutions that are illegible or do not contain enough information to be able to provide feedback. This score will not be used for standards where you have previously demonstrated understanding

Your review score will be the number of standards where you have demonstrated understanding by the end of the course.

Each review will have one question for each of the 5-7 new standards, based on the material since the previous review. After the first midterm, each midterm will also have one question for each of standards on the previous midterm. The Final Review will have one question for each standard in the course. Once you have demonstrated understanding of a standard, you do not need to answer the questions on future reviews.

Here is a chart of the standards are on each review:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Review 1	√	√	√	√	√	√	√															
Review 2	√	√	√	√	√	√	√	√	√	√	√	√	√									
Review 3								√	√	√	√	√	√	√	√	√	√	√				
Review 4														√	√	√	√	√	√	√	√	√
Final Review	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

Ways to get help

The best way to succeed in this course is to ask for help before you fall behind. This includes working with your classmates and asking questions during class. Here are other ways to get help:

- **Office hours**: Office hours are a time I am in my office to help you with the material in the course. They can also be a time to meet or work with other students in the class.
- **Embedded tutor**: Delario Nance has been an embedded tutor for this course before. He will have office hours just for this course, where you can ask questions or work with other students on the homework.
- **Slack:** For questions about course material or logistics, check the Slack—someone else may have already asked the same question. If not, you should post, as other students likely have the same question. Other students in the course and Delario can answer your questions in Slack.
- **Email**: For questions containing private information such as grades or absences, contact me by email. I will respond to Slack messages and emails within 24 hours on weekdays.
- **Study Groups**: I strongly encourage you to work with your peers on homework and when studying for reviews
- **Math and Science Center (MSC)**: Our embedded tutors should be your primary source for peer assistance and learning support this semester. The Math & Science Center (MSC) will also have a small number of additional peer tutors available on a drop-in or by-appointment basis. Located in the Center for Teaching & Learning (CTL) on the first floor of the College Library, the MSC's drop-in hours are Sunday through Thursday, 8-11 PM, beginning September 4. Visit https://www.davidson.edu/offices-and-services/center-teaching-and-learning/student-resources/ and navigate to the Math, Science, & Economics Center to determine when a tutor for our course will

be present or to schedule an appointment with a tutor. Peer assistance is free to Davidson students. For more information, contact Dr. Mark Barsoum, Director of the MSC (mabarsoum@daivdson.edu or ext. 2796).

Other course policies

Make-up Policy

If you need to miss class due to excused absence, we will schedule a time for the . Note: this is not a replacement for attending class and intended for short term (less than one week) illnesses, family emergency, college sponsored travel, or religious holidays. Some excused absences may require documentation.

If you are dealing with longer term illnesses or other life events that are interfering with your ability to attend class or complete assignments, reach out to me about how to handle assignments. These may require documentation.

Honor Code

The Honor Pledge of Davidson College states: “On my honor I have neither given nor received unauthorized information regarding this work, I have followed and will continue to observe all regulations regarding it, and I am unaware of any violation of the Honor Code by others.” This pledge applies to all work for our course.

Your preparation assignments and homework assignments will be submitted individually. Though you may discuss your solutions with any of your classmates, you are expected to write your final submissions on your own. If you work on a problem with someone else (in or out of class) you should acknowledge this collaboration on the cover page for the homework assignments and on the preparation assignments.

Any copying of work which is not your own is an Honor Code violation. In addition, allowing others to copy your work (in person or by making it available electronically) is an Honor Code violation. Honor Code violations will be reported to the Honor Council. Assignments with Honor Code violations will receive a 0.

If you use a source that is not our textbook, course notes, or a resource on Moodle, you must cite them on the cover page for the assignment. You do not need to use any specific format for your citations–just provide enough information that I can find the resource. You may not look up solutions to any problem assigned in the course on the internet. Once you have seen a full solution, it is not possible to independently develop a solution.

Academic Access

The college welcomes requests for accommodations related to disability and will grant those that are determined to be reasonable and maintain the integrity of a program or curriculum. To make such a request or to begin a conversation about a possible request, please contact the Office of Academic Access and Disability Resources, which is located in the Center for Teaching and Learning in the E.H. Little Library: Beth Bleil, Director, bebleil@davidson.edu, 704-894-2129; or Alysen Beaty, Assistant Director, albeaty@davidson.edu, 704-894-2939. It is best to submit accommodation requests within the drop/add period; however, requests can be made at any time in the semester. Please keep in mind that accommodations are not retroactive.

Important Dates

August 29	Classes Begin
August 29-September 2 (5 pm)	Add/Drop Week 1 available to all students on Banner Self-Service
September 2 (5pm)**- September 9** (5 pm)	Add/Drop Week 2 available through the Add/Drop Permission Form only ($20 fee).
	Adds or Drops not permitted after September 9.

October 10-11	Fall Break, No Classes
November 23-25	Thanksgiving Break, No Classes
December 9	Reading Day, No Classes
December 12-16	Final Exams

Tentative Course Schedule—Subject to change

August 30 September 1	Introduction to the course, start of §1.1 Systems of Linear Equations Finish §1.1 Systems of Linear Equations, §1.2 Row Echelon Form	
September 6 September 8	§1.2 Reduced Row Echelon Forms, §1.3 Vector Equations *Mathematica Lab 1 (Introduction to Mathematica and Systems of Linear Equations)—LIB B110*	 Homework 1 due
September 13 September 15	§1.4,1.5 Matrix Equations and Solution Sets *Mathematica Lab 2 (Span of 2D vectors as a Guessing Game and §1.6 Applications of Linear Systems)—LIB B110*	 Homework 2, Lab 1 due
September 20 September 22	§1.5 Solution Sets of Linear Equations §1.7 Linear Independence (Note: No Lab)	 Homework 3, Lab 2 due
September 27 September 29	**Review 1** §1.8, 1.9 Linear Independence and Linear Transformations *Mathematica Lab 3 (Graphical Linear Transformations)—LIB B110*	
October 4 October 6	§1.8, 1.9 Linear Independence and Linear Transformations, §2.1 Matrix Operations §2.2, 2.2, 2.3 Invertible Matrices and Inverse of a Matrix (Note: No Lab)	 Homework 4, Lab 3 due
October 11 October 13	**No class—Fall Break** *Mathematica Lab 4 (§2.7 Applications of Matrices and Linear Transformations to Computer Graphics)—LIB B110*	 Homework 5 due
October 18 October 20	§3.1, 3.2 Determinants §3.3 Determinants as area and volume, Linear Transformations *Mathematica Lab 5 (Determinants and Linear Interpolation)—LIB B110*	 Homework 6, Lab 4 due
October 25 October 27	**Review 2** §2.8, 2.9 Subspaces and Dimension (Note: No Lab)	 Lab 5 parts 1& 2 due
November 1 November 3	§4.1 Vector Spaces §5.1, 5.2 Eigenvectors and Eigenvalues (note: No Lab)	 Lab 5 parts 3 & 4 due

November 8 November 10	§5.3 Diagonalization and §5.6 Discrete Dynamical Systems *Mathematica Lab 6 (§4.9 Applications to Markov Chains)—LIB B110*	 Homework 7 due
November 15 November 17	**Review 3** §6.1, 6.2, 6.3 Orthogonality and Projections (note: No Lab)	 Lab 6 due
November 22 November 24	§6.1b, 6.4 Subspaces and the Gram-Schmidt Process **No class—Thanksgiving**	Homework 8 due
November 29 December 1	Catch-up Day and Chapter 6 Summary §7.4 Singular Value Decomposition Course Evaluation (note: No Lab)	 Homework 9 due
December 6 December 8	**Review 4** *Mathematica Lab 7 (Singular Value Image Decomposition)—LIB B110*	 Lab 7 due Friday
December 12-16	Final Exam—self scheduled, taken in Chambers Exam Center	