MAT-150: Linear Algebra, Spring 2024

Section A: TR 8:15-9:30 AM

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

Wall 380

Prerequisite: MAT 113 (Calc 2) or placement above 113

Instructor: Claire Merriman

Email: clmerriman@davidson.edu

Office: Chambers 3043

Office Hours: See Moodle

Embedded Tutors:

Email:

Location:

Office Hours:

Course Grades:

Preparation Assignments	5%
In Class Activities	5%
Homework	15%
Mathematica Labs	16%
Standards	60%

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

January 25, February 1, February 13, February 22, March 12, April 4, April 18, April 25

Review Dates:

Minis: January 30-31, April 29-30

February 20-21, March 12-13, April 2-3, April 23-24

Final Exam in Exam Center, May 3-6 or May 8

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, or you may use the online version. More information is available on Moodle.

Online Homework Submission: All homework, lab, and preparation assignments will be submitted on Gradescope. You will also find your grades and feedback on all 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.

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 factorization

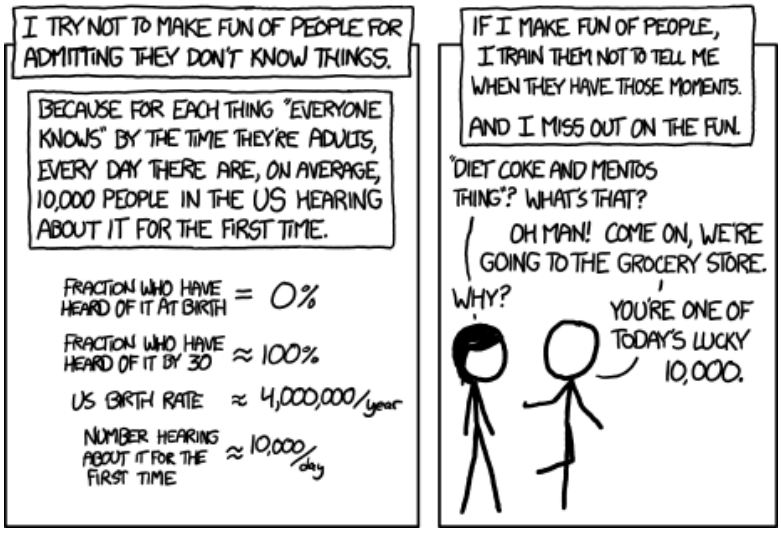
Classroom Expectations

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 are due at the start 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 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 a mix of accuracy and completions. Since the lecture portion of class is important for being able to contribute to group discussion, excessive tardiness or leaving early will result in a reduced individual score:

- 10 to 15 minutes late or leave 5 to 10 minutes early: 3 points deducted from score.
- 15 to 20 minutes late or leave 10 to 15 minutes early: 5 points deducted from score.
- More than 20 minutes late, leave more than 15 minutes early, or unexcused absence: 0 points.

The instructor reserves the right to deduct additional points for distracting behavior, creating a hostile group environment, or lack of active participation in group work.

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. All problems will be graded on accuracy of the mathematical argument and clarity of the explanation.

Homework is due on Gradescope by the beginning of class on Thursday. Late homework assignments will receive a 20 percentage-point penalty per day, unless you are using one of your late passes. 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. Leave enough room for each problem and write them up in order. Problems or assignments that are messy may result in lower grades. 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 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, §5.6 Discrete Dynamical Systems, 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.

Reviews

We will use a standards-based grading system for the reviews. There are 24 *standards* in the course. Your review grade is based on how the number of standards where you have **Demonstrated Understanding**. Each problem will receive one 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 4-6 new standards, based on the material since the previous review.

There will be a 35-minute mini review outside of class the week of January 30. There will also be four 75-minute reviews outside of class throughout the semester. There will be several chances to take each review, with the times announced by the end of the first week of classes.

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	23	24
Mini Review A	√	√	√																					
Review 1	√	√	√	√	√	√	√	√																
Review 2	√	√	√	√	√	√	√	√	√	√	√	√	√	√										
Review 3									√	√	√	√	√	√	√	√	√	√	√					
Review 4															√	√	√	√	√	√	√	√	√	√
Mini Review B																				√	√	√	√	√
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**:
- **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 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)**: Your primary source of peer learning support and assistance for this course should be our embedded tutor. Please attend their scheduled help sessions, visit them in their office hours, and ask them questions through e-mail or our online platforms. You may also

schedule individual appointments with them as their schedule allows. The exact schedule for help sessions and office hours with the embedded tutor(s) will be announced shortly.
The Math & Science Center (MSC) will also have a small number of additional peer tutors available on a drop-in or by-appointment basis. The embedded, drop-in, and by-appointment tutors are trained and highly qualified peers that demonstrated deep understanding and succeeded in this course themselves. 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 Sunday, January 21. Prior to visiting for drop-in help, be sure to look at the tutor schedules to determine when an appropriate tutor for your course/topic will be present. Tutor schedules for drop-in assistance, as well as links to schedule an appointment with a tutor, can be found at https://www.davidson.edu/offices-and-services/center-teaching-and-learning/student-resources/math-science-and-economics-center (click on "Meet with Math or Science Tutor"). Peer assistance is free to Davidson students at the point of service. For more information, contact Dr. Mark Barsoum, Director of the CTL (mabarsoum or ext. 2796).

Other course policies

Late Work

You may use 4 late passes during the semester. A late pass will allow you to turn in homework or labs up to 24 hours late without penalty—you may not use more than one late pass on the same assignment. You do not need to ask ahead of time, just write LATE PASS on the assignment. You are responsible for keeping track of when you have used all of your late passes.

Late work will receive a 20 percentage-point penalty per 24 hours. That is, an assignment with 20 total points will receive a 4 point deduction per 24 hours, a 50 point assignment will receive a 10 point deduction, etc. No work will be accepted more than 5 days after the deadline.

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 by emailing AADR@davidson.edu. 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

January 16	Classes Begin
January 16, 7 am**- January 19,** 5 pm	Add/Drop Week 1 available to all students on Banner Self-Service
January 19, 5 pm**-January 26,** 5 pm	Add/Drop Week 2 available through the Add/Drop Permission Form only ($20 fee).
	Adds or Drops not permitted after September 9.
March 4-8	Spring Break, No Classes
March 29	No Classes
April 11	Spring Convocation, No Afternoon Classes
May 1	Verna Miller Case Research & Creative Works Symposium, No Classes
May 2	Reading Day, No Classes
May 3-8 (May 3-6 for seniors)	Final Exams

Tentative Course Schedule—Subject to change, Defer to Schedule on Moodle

January 16	Introduction to the course, start of §1.1 Systems of Linear Equations	Nothing Due	
January 18	Finish §1.1 Systems of Linear Equations, §1.2 Row Echelon Form	Preparation: §1.1	
January 23	§1.2 Reduced Row Echelon Forms, §1.3 Vector Equations	Preparation: §1.2	
January 25	*Mathematica Lab 1 (Introduction to Mathematica and Systems of Linear Equations)*	Preparation: Prelab 1 Homework 1: §1.1-1.2	
January 30	§1.4 Matrix Equations	Prep: §1.4	**Outside of class Mini Review**
February 1	*Mathematica Lab 2 (Span of 2D vectors as a Guessing Game and §1.6 Applications of Linear Systems)*	Preparation: Prelab 2 HW 2: §1.3 Lab 1 due	
February 6	§1.5 Solution Sets of Linear Equations, §1.7 Linear Independence	Preparation: §1.5	
February 8	§1.7 Linear Independence, §1.8 Matrix of a Linear Transformation	Preparation: §1.7 Homework 3: §1.4 Lab 2 due	
February 13	§1.9 Linear Transformations *Mathematica Lab 3 (Graphical Linear Transformations) —WALL 380*	Preparation: §1.9	
February15	§2.1, 2.2 Matrix Operations and Invertible Matrices	Preparation: §2.1 Homework 4: §1.5,1.7-1.8	
February 20	§2.3 Invertible Matrices	**Outside of class** **Review 1—Chapter 1**	
February 22	*Mathematica Lab 4 (§2.7 Applications of Matrices and Linear Transformations to Computer Graphics)*	Preparation: Prelab 4 Lab 3 due	
February 27	§3.1, 3.2 Determinants	Preparation: §3.1	
February 29	§3.3 Determinants as area and volume §2.8 Subspaces of **R,** §4.2 Null Space, Column Space, and Linear Transformations	Preparation: §3.3 Homework 5: §1.9, 2.1-2.3 Lab 4 due, Bonus Lab due	
Spring Break			
March 12	*Mathematica Lab 5 (Determinants and Linear Interpolation)*	**Outside of class** **Review 2—Sections 2.1-2.3, 3.1-3.3**	
March 14	§2.8 Subspaces of **R,** §4.3 Linearly Independent Set; Bases, §4.5 The Dimension of a Vector Space	Preparation: §2.8	
March 19	§2.9 Dimension and Rank, §4.3 Linearly Independent Set; Bases §4.6 Rank	Preparation: §2.9	
March 21	§4.1 Vector Spaces	Preparation: §4.1 Homework 6: §3.1-3.3, 2.8, 4.2,4.3 Lab 5 due	
March 26	§4.4 Coordinate Systems	Preparation: §4.4	

March 28	§6.1, 6.2, 6.3 Orthogonality and Projections	Preparation: §6.1 Homework 7: §2.8-2.9,4.1-4.6
April 2	§6.1b, 6.4 Subspaces and the Gram-Schmidt Process	**Outside of class** **Review 3—Sections 2.8-2.9, 4.1-4.6**
April 4	*Mathematica Lab 6 (*Null Spaces, Column Spaces, and Linear Transformations and Gram-Schmidt*)*	Preparation: Prelab 6
April 9	§5.1, 5.2 Eigenvectors and Eigenvalues	Preparation: §5.1
April 11	§5.3 Diagonalization	Preparation: §5.3 Homework 8: §6.1-6.4 Lab 6 Due
April 16	§5.6 Discrete Dynamical Systems	Preparation: §5.6
April 18	*Mathematica Lab 7 (§4.9 Applications to Markov Chains, §5.6 Discrete Dynamical Systems)*	Preparation: Prelab 7 Homework 9: §5.1-5.3
April 23	Course Evaluation §7.4 Singular Value Decomposition	**Outside of class** **Review 4—Sections 5.1-5.3, 6.1-6.4**
April 25	*Mathematica Lab 8 (Singular Value Image Decomposition)*	Preparation: Prelab 8 Lab 7 due
April 30	No class, classes follow Friday Schedule	Lab 8 due
May 3-8	Final Exam—Exam Center (pickup at 8:40 a.m. and 1:40 p.m). • Friday, May 3 • Saturday, May 4 • Sunday, May 5 • Monday, May 6 • Wednesday, May 8 (non-seniors only)	