Math 215 – Linear algebra
Sections 2 and 5 – Spring 2024

Instructor
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Mentor
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Course meetings
Section 2 – 10:00-10:50am
Noyce 3821
Section 5 – 3:00-3:50pm
Noyce 2517

What is this course? Linear algebra is the study of lines, planes, their higher dimensional friends, linear transformations, and matrices. Linear algebra is foundational for pure and applied mathematics, and important for computer science, chemistry, physics, and other fields. The high level outline is:

Weeks 1-3	Language and symbolism of logic and proof-writing
Weeks 4-7	Linear algebra in two dimensions
Weeks 8-14	Linear algebra in more than two dimensions

Course objectives: By the end of the semester, a successful student will be able to:

- Use the language and symbolism of mathematical logic: and, or, not, implies (if-then), quantifiers (there exists, for all), contrapositives, and notation for sets and functions.
- Use basic concepts of linear algebra in both computation and proof-writing. Key concepts include vectors, vector spaces, linear transformations, matrices, spanning, linear independence, dimension, solving systems of linear equations, determinants, eigenvalues, and eigenvectors.
- Write articulate, coherent, and rigorous mathematical proofs (for linear algebra), utilizing methods such as contrapositives and proof by contradiction.

Course policies

Textbook: *Linear Algebra* by Professor Joe Mileti, available at
`https://mileti.math.grinnell.edu/m215f22/LinearAlgebra.pdf`.

Communication and online resources: We will use Blackboard, Gradescope, and email. To join the Gradescope course, use the code XX4J5P. Homework assignments will be posted on Blackboard and submitted on Gradescope. The best way to communicate with me is email or conversation after class.

Office hours and mentor sessions: Office hours are a chance for you to come and talk to me about anything related to the course. If they don't fit your schedule, email me and we'll make an appointment.

Mentor sessions will be run by Mira, our course mentor. At mentor sessions, you can get help from Mira and other students.

What	Time	Days	Location
Office hours	11-11:30am	Monday, Wednesday, Friday	Noyce 2516
Office hours	2:30-3pm	Monday, Wednesday, Friday	Noyce 2516
Office hours	3-4pm	Thursday	Noyce 2516
Office hours	10-11am	Tuesday	Saint's Rest coffee shop
Mentor session	8-9:30pm	Tuesday, Thusday, Sunday	Noyce 2245

Accommodations: If you have a documented disability, I probably already received an accommodation letter from Disability Resources, but please come chat with me about it as well, so that we can work together to make appropriate accommodations.

Absences: Let me know as soon as possible if you will miss class to observe a religious holiday, play in a college sporting event, etc. so we can plan how you can still meet the requirements of the course.

If you will miss a (non-exam) class for a mundane reason (such as being sick), please do not email me. The full schedule of topics is contained in this syllabus, and it is your responsibility to consult Blackboard or talk to other students to get any notes you have missed.

LaTeX: You are not required to learn or use LaTeX for this course, but I encourage you to try if you are interested in typing mathematics and making it look good. Learning LaTeX is hard at first, but pays off big time once you master the basics. Some introductory resources are available on Blackboard, and I can also answer questions about LaTeX via email or in office hours.

Academic honesty: Make sure you are familiar with the college's academic honesty policy available at `https://www.grinnell.edu/sites/default/files/docs/2021-09/2021-22_Academic_Honesty_booklet_accessible_0.pdf`. There are serious consequences if you are found to be in violation of one of these policies.

Generative AI: There are now many tools for producing written text using AI. It is not necessarily a violation of academic honesty policies to use these. However, it is a violation of academic honesty policy to submit writing produced by generative AI without citing any sources.

In general, think of things said by a generative AI as you would think of something your roommate said. Your roommate is not a source you can cite for a proof or an academic research paper. You cannot assume things they say are correct without checking. The same goes for AI. They make mistakes, so you need to verify what they tell you by consulting other sources.

Academic support and academic alerts: The academic advising office has many resources for struggling students, and can help connect you with a variety of campus resources. To the best of my abilities, I try to be aware of struggling students, and if I notice you are encountering difficulty, I will communicate with you about it (by email), and may submit an academic alert. An academic alert notifies the academic advising team and your advisor so that they can reach out to you with additional offers of support.

Grades

10%	Daily reading questions and attendance
36%	Homework
36%	Exams (3 exams, so 12% each)
18%	Final exam

$[95, 100]$	A
$[90, 95)$	A-
$[87, 90)$	B+
$[84, 87)$	B
$[80, 84)$	B-
$[75, 80)$	C+
$[70, 75)$	C
$[60, 70)$	D
$[0, 60)$	F

The final exam will replace your lowest midterm (assuming the final exam is higher).

Daily reading questions: Each day there will be 2-3 short questions on Gradescope asking you to respond to something in the reading. Credit is 50% completion and 50% accuracy. For example, if there are two questions and you get one right and one wrong, you have earned 75% of the credit.

Homework: There will be a homework set due every before class period. Problems will be posted on Blackboard and turned in on Gradescope. Each problem set contributes equally to the grade, regardless of point totals. The lowest three problem sets will be dropped. Late submissions will be graded at 50% credit up to one week after the deadline, and will generally get less feedback. After that no credit will be given for late submissions.

You are encouraged to work with classmates on homework. When you do this, make sure your submitted assignment is written in your own words, and acknowledge your collaborators in writing. For example, write "I worked together with Joshua on this problem." **It is never acceptable to consult a fully-formed solution on the internet.**

Writing problems: Other problems on homework may require you to write short proofs, but the last problem will always be a "Writing problem." It will usually require you to write a proof, and will be held to higher standards in terms of writing quality and complete arguments. They may require you to extend or generalize ideas discussed in class or the textbook. You will be expected to use complete sentences and coherent arguments, supplemented with math symbols only as necessary. I recommend sketching your argument on scratch paper before you write it out fully.

On each assignment, you will have a chance to submit a revised solution of the writing problem from the assignment from three class periods ago. For example, for the first assignment due on Tuesday January 23rd, you can resubmit a revisted solution for that writing problem on the Tuesday January 30th assignment.

Exams: There will be three in-class exams and a cumulative final exam. You will not have access a calculators, but will be able to bring a 3x5 note card with anything written on it. All exams will be in our regular classroom.

Day	What	Time
Wednesday, February 14	Exam 1	Regular class period
Wednesday, March 13	Exam 2	Regular class period
Monday, April 22	Exam 3	Regular class period
Tuesday, May 14	Final exam, section 2	2-5pm
Wednesday, May 15	Final exam, section 5	9am-noon

If you wish to take the final exam with the other section, let me know at least one week before finals and we can discuss it.

Advice on how to succeed in this course:

- Read the listed section of the textbook before we discuss it in class, then read it again after class. Read actively and thoroughly – if you don't follow a calculation, get out paper and pencil and try to work it out. Pause regularly to think and process, to build connections in your brain, and to organize new ideas into useful mental models.

- Spend time with graded work to understand the feedback. You should expect to spend about 9 hours outside of class per week on reading the textbook, working on homework, etc. Find a regular group of 2-4 to work on homework together, if you can. If you're having trouble with this, come chat with me and maybe I can help link you up with a group.

- You are beginning the transition from computational mathematics to conceptual mathematics. In a calculus course, the answer to a question is usually a number or a function. In advanced mathematics, the answer to a question is a fully-reasoned argument. This course has plenty of both. You will encounter many computational problems where the answer is a number or a vector or a matrix, but you will also learn to construct logical arguments and write them down as proofs.

  Proof-writing can be intimidating, but it is similar to writing a paragraph or series of paragraphs in an essay. Use complete and grammatical sentences, avoid unnecessary wordiness, and generally try to communicate effectively to your reader.

- The Essence of Linear Algebra video series on the 3Blue1Brown YouTube channel gives an accessible overview of many linear algebra topics in this course. I highly recommend you watch these around weeks 3-4.

- There are many textbooks on linear algebra. I encourage you to consult something other than our textbook on occasion, to see other perspectives.

Schedule

Day	Section	Topic	HW
Week 1			
January 22	1.1-1.2	Mathematical statements	
January 24	1.3	Quantifiers and negations	HW1
January 26	1.4	Even and odd numbers	HW2
Week 2			
January 29	1.4	Contrapositives and proof by contradiction	HW3
January 31	1.5	Sets, subsets, and set equality	HW4
February 2	1.6	Functions	HW5
Week 3			
February 5	1.7	Injective, surjective, bijective functions	HW6
February 7	1.8, 2.1	Solution sets and intersections of lines in $\mathbb{R}^2$	HW7
February 9	2.2	Vectors in $\mathbb{R}^2$	HW8
Week 4			
February 12	2.3	The span of one or two vectors	HW9
February 14		Exam 1	(none)
February 16	2.4	Linear transformations of $\mathbb{R}^2$	(none)
Week 5			
February 19	2.5	Standard matrix of a linear transformation	HW10
February 21	2.5	Rotations, projections, and reflections	HW11
February 23	2.6	Matrix algebra	HW12
Week 6			
February 26	2.7	Range, null space, and inverse of a linear transformation	HW13
February 28	3.1	Coordinates and change of basis	HW14
March 1	3.2	Matrices with respect to other coordinates	HW15
Week 7			
March 4	3.3	Eigenvalues, eigenvectors, and characteristic polynomials	HW16
March 6	3.3	Diagonalization	HW17
March 8	3.4-3.4	Diagonalization, determinants	HW18
Week 8			
March 11	3.4	Determinants	HW19
March 13		Exam 2	(none)
March 15		Some applications	HW20
March 18-29		Spring break	

Week 9			
April 1	4.1	Vector spaces	(none)
April 3	4.1	Vector subspaces	HW21
April 5	4.2	Solving linear systems with augmented matrices	HW22
Week 10			
April 8	4.2	Balancing chemical equations using row reduction	HW23
April 10	4.3	Spanning sequences	HW24
April 12	4.4	Linear independence	HW25
Week 11			
April 15	4.5	Bases and coordinates	HW26
April 17	4.6	Dimension	HW27
April 19	4.6	Dimension	HW28
Week 12			
April 22		Exam 3	(none)
April 24	5.1	Linear transformations revisited	(none)
April 26	5.2	Range and null space revisited	HW29
Week 13			
April 29	5.2	Rank and nullity	HW30
May 1	5.3	Determinants revisited	HW31
May 3	5.3	Determinants by cofactor expansion	HW32
Week 14			
May 6	5.3	Eigenvalues and eigenvectors revisited	HW33
May 8	54	Eigenvalues and eigenvectors continued	HW34
May 10	5.4	Catch up day	HW35
Exam week			
May 14 (Tue)	2-5pm	Final exam for section 2 (10am section)	
May 15 (Wed)	9am-noon	Final exam for section 5 (3pm section)	