MATH 271: Linear Algebra

Classroom: SMUD 014

—————————————————

Instructor Info —

- Dr. Miriam Kuzbary
- Pronouns: she/her/hers
- Call me: Prof. Kuzbary, Dr. Kuzbary, or Miriam
- Office Hours: M 2-3pm on Zoom, W 3-4pm in person
- Office: SMUD 013
- Course Website: On Moodle
- mkuzbary@amherst.edu

Course Info ———

- Prereq: A grade of C or better in MATH 211 or 220, placement into MATH 271, or instructor consent.
- Mon, Wed, Fri
- 11:00am-11:50am
- SMUD 014

About ——————

Welcome to Linear Algebra! Perhaps you have noticed that many math computations you've done before now have seemed vaguely familiar: two real numbers add to get another real number, two vectors in the plane add to get to get another vector in the plane, and two polynomials add to get another polynomial. In this course, we will work to understand what fundamental algebraic properties all these objects (and others) share, and use those properties to build a general theory of Linear Algebra!

What you'll learn along the way

Throughout this semester, you should plan to work towards the following goals:

- Prove theorems, propositions, and corollaries about linear algebra topics, such as vector spaces and linear transformations,
- Perform linear algebra computations, such as row reducing matrices, finding eigenvalues, and changing bases,
- Develop your geometric intuition and fluency in switching between algebraic and geometric understanding of the same problems,
- Deepen your understanding of algebra as studying structures and not just doing individual problems,
- Expand your independence as a math learner and practitioner.

Mutual Expectations

Learning new mathematics is a difficult thing to do, and takes a lot of work and time! That said, you are *completely capable of mastering this material if you are willing to put in the time, attention, and strategic effort into learning how to do linear algebra.*

That said, mathematics is not a spectator sport! For example, if you are trying to learn how to swim, watching someone swim and explain swimming technique to you is certainly not going to be enough to prepare you to jump in the water and win a race by itself. Math is a physical skill that takes focused practice over time to improve. You might even not notice your progress as it is happening!

As with any college math class, simply attending the class without doing work to learn outside of our class time will not be enough to succeed in the course. However, I'm here to help you figure out how your work in this course outside of our class time together can be most beneficial to you!

Some of the things you can expect from me:

- The most important thing to me is that you learn something in this class, and that will require work on both of our parts! I have the responsibility and joy of helping you learn linear algebra, and that also means that often if you ask me how to do something you will learn more if I guide you to think about the problem rather than directly responding with the correct final answer.
- I have been teaching and tutoring for quite some time (15 years). Students from a huge range of backgrounds and with many different kinds of preparation for college math have succeeded both in my classes and others I have helped them with. This means when I make choices in the classroom or suggest something for you to try, it's because I have seen it work for multiple people!
- I am committed to creating a learning environment in which all of my students feel safe and included. Our classroom is a living community that will change and grow based on our participation and interaction in it, and as its facilitator I will constantly work to help it be a place of trust, curiosity, and mutual respect where learners with many different communication styles, needs, and goals can participate meaningfully. I hope you will, too!
- I will also work to allow for as many different students to speak in each class session as possible, which will involve a few strategies. Some of these include: allowing for 1-2 minutes after each question so that all students have time to process the question and think about how they'd like to answer, asking you to discuss a question in pairs for 3-4 minutes and then calling on a pair to tell me what they talked about, or waiting to call on someone until at least 4-5 hands are raised to talk.
- I will do my best to clearly communicate expectations and standards in this class, and will regularly solicit feedback from you on how it's going,
- I will respond to your emails within one business day (meaning Monday through Friday, excluding holidays), during normal business hours (9am-5pm) unless it is an emergency, in which case I will do my best to respond sooner. You can always email me questions at any time, including about specific problems or proofs!

FAQs

? How many hours should I expect to spend each week on this class?

! Our class meets for 3 hours a week, so you should expect to spend at least 9 hours per week on this course according to the Amherst Course Catalog, regardless of whether we have an exam or not. One effective way to do this is to use the study cycle (which you can google for more details):
1) Before class preview the material for next class to prime yourself to see it in more detail during class.
2) Attend class, participate, and take notes!
3) Review topics from the class you attended AS SOON AS POSSIBLE after class, even if it is just for a short period of time (even 10 minutes).
4) Schedule several focused study sessions per week for yourself. These don't have to be long; multiple brief (30 mins-1 hour) intense sessions with breaks in between is a less stressful and more effective strategy for learning than marathon cram sessions before exams.
5) Check in with yourself regularly to make sure what you're doing is working! Quiz yourself on class material, and ask yourself some metacognitive questions like "what questions will I ask myself next time I'm working these types of problems?", and "how does this information relate to what we learned last week?"

? What if I get sick?

! If you are showing symptoms of a contagious illness and/or testing positive for COVID-19 on a regular class day, please follow the Amherst College *protocols* and do not come to class. If it is an exam day, please email me immediately to schedule a makeup exam.

Some of the things I will expect from you:

- Approach this course with curiosity and commitment: some struggle is expected and is necessary for learning mathematics! I will *never ask you to do something I don't believe you are capable of doing*, and generally we all learn and grow the most when we try things that feel difficult!
- Take responsibility for your learning in this class and be flexible: if what you've done so far in the course isn't giving you the results you want, be open to changing how you are studying, doing homework, participating in class, or participating in office hours and math fellow hours (among other things). Make sure you are aware of deadlines and assignments.
- Trust yourself that you are capable of meeting the expectations I have for you in this course. Mistakes are good: they help you clarify how you are understanding the material and where you have more room to grow!
- Use our class time effectively and treat your fellow class members with respect and care. This can include asking questions, even if they feel silly, because if you have a question there are usually at least 5 other students with the same question who aren't speaking up! Participating in class in a respectful way also includes listening to your classmates, stepping up to take space when appropriate, and allowing other class members to take up space when appropriate.
- If something is going on with you that affects your participation in this class, please tell me as early as possible!
- Read the entire syllabus carefully, familiarize yourself with the entire course Moodle page, and check your email every day, even if you take a business day to respond to non-urgent emails.
- If you have a concern about a grade you've earned on an assignment, reach out to me AS SOON AS POSSIBLE. I and the graders won't be able to address regrade requests or concerns about a grade if we get them more than one week after you have received the grade.

The components of this course and their purpose

In-class work, discussion, and lecture

During our lecture time we will have many conversations about what we are learning, so come to class expecting that you will be both contributing to the discussion and taking away something interesting to think about. We are creating this class together. The in-class portion of this course is time to engage with material together, ask questions, and do practice problems and proofs with immediate feedback from me. Our class time is also your opportunity to think out loud, make mistakes, and ask questions!

You will also be doing problems and coming up with proofs in class, both in groups and by yourself. Even though this can feel challenging and less productive than simply watching me do examples and write the proofs from start to finish, there is massive amounts of data such as in this metastudy from the Proceedings of the National Academy of Sciences (Deslauriers, McCarty, Miller, and Callaghan) demonstrating the opposite is true! You will learn more, and are statistically more likely to pass this course, if you take an active role in your own learning in class.

Studying and learning outside of class

We only spend 3 hours in class each week together, and as mentioned in the FAQ, you should plan to spend at least 9 hours outside of class each week on this class. Therefore, the time you spend outside of class on this material is the single biggest component of the course!

The time outside of class you spend learning and studying is how you develop your own perspective on the course material, deepen your understanding, and strengthen your skills.

Check-In Quizzes

There will be short open book, open note quizzes on Moodle due on Mondays at 11:59pm to help you check in with yourself (and me) on where you are in the course material. I will drop your lowest score.

Homework

There will be one homework assignment per week, due on *Thursdays by 11:59pm* through Gradescope. I will not accept homework in person, you must scan it and turn it in online. Homework turned in after the due date will not be accepted (see the special arrangement section of the syllabus for extension policies). In order to make sure your work is organized well, please make sure you write legibly and label the problems in the same order as listed in the assignment.

Homework gives you an opportunity to get feedback on your demonstrated understanding of course material outside of an exam. That said, you would probably prefer to make mistakes on the homework and learn how to fix them before an exam than make a mistake for the first time on an exam! This means homework will be most beneficial to you if you study the material and look at examples before you start the related homework, and push yourself to do the homework in a closer to exam-style environment! Try not to flip back to example problems unless you have given a problem a serious try without any help, and the more comfortable you feel with a specific topic, the more you should push yourself to work on problems on that topic without input from any other source.

Because you will get the most out of your homework if you are open to pushing yourself, even if you don't totally understand the material yet, *I will drop your lowest homework score*. There will also be three opportunities to revise and resubmit a previous assignment to completely replace your grade: *February 20, March 27, and April 30.*

Working in groups and talking through your ideas is a great thing to do, and a skill that will be invaluable throughout your mathematical journey. However, your homework write-ups must be written individually. Copying or paraphrasing the work of others is plagiarism and is *a violation of the honor code*. This includes using ChatGPT, Wolfram Alpha, or any other computational website or software. If you happened to work on an assignment with other people and you all came up with the same solution, please write the name(s) of the other students involved.

Finally, if you talk to other students about the homework problems *do not give unsolicited answers to your classmates*. The ideal discussion of the homework is one where everyone involved has tried the problem already, and everyone in the discussion is given space to try out their ideas.

Exams

There will be 3 midterm exams in class and one comprehensive final exam.

Midterm Exam 1	Friday, February 9
Midterm Exam 2	Friday, March 8
Midterm Exam 3	Friday, April 12
Final Exam	TBA

An important part of learning the material in this course is gaining fluency in the concepts, computations, and proofs we are learning together. Being able to succeed on an exam without external resources is part of being able to demonstrate that fluency. For example, if you wanted to become fluent in a new language, one of your goals would probably be to be able to have a basic conversation without having to refer to a dictionary for most of the words and grammatical structures during the conversation (this is one of the skills distinguishing different levels of fluency in a language by the ACTFL and CTFR scales).

More importantly, the kind of deep studying required for an exam allows you to engage in the material in a different way and learn the material more thoroughly. Think about it this way: would you study harder for a class with no exams or a class with exams?

Finally, exams provide valuable feedback for both of us on specific things you are understanding and not understanding in this course, and can help both of us make an informed decision about how the class is going. *I will replace your lowest midterm exam grade with your highest midterm exam grade when I am calculating your final grade in the course.*

Extra Credit

There will be many opportunities for extra credit in this course through the following mechanisms:

Practice Exams: One week before each exam, I will give you a detailed study guide with topics that will be on the exam, practice questions, and suggestions for how to study. This guide will also include general facts about the format of the exam. If you use this to create your own practice exam with full solutions and turn it into me the Wednesday before the midterm or final, you will earn extra credit.

Groups and how-to videos: After the first week, I will assign you into a small group of 4-5 students. You will have your own space on Moodle to communicate with each other if you would like to use it. Since one of the best ways to learn something is to teach it to someone else, you will each have the opportunity to earn extra credit once per month starting in February by

sharing a short (3-7 minute) how to video of yourself to your group explaining how to do a problem from an exam or homework assignment you choose. These videos will be graded by completion.

Note that these groups are still part of the course, and expectations of respect, care, and following the Amherst College Honor Code still apply, including to your video. I take issues of misconduct and harm very seriously, and if there are issues in a group please let me know privately and as soon as possible.

Office hours and Math Fellow Hours

Office hours with myself, the Math Fellows, and Min Winton at the Q Center are your time to have smaller group interaction and feedback with us to clarify concepts, ask questions, and get help if you are stuck on a problem. They will be most effective if you prepare for them by attempting the homework first, reviewing both your class notes and mine, and reading the textbook.

Office hours supplement the rest of the components of this course, but they *cannot replace any other component of the course*. For example, the Math Fellows and I can't do your homework for you, but we can coach you towards figuring it out yourself!

Office Hours with QFellow Min Winton

Drop-In Hours TBA For appointments with her, click here.

Math Fellow Office Hours starting the week of Feb 4

(Location TBA)
Sundays 6pm-7:30pm Yvan Grinspan
Mondays 7:30pm-9pm Yvan Grinspan
Tuesdays 7:30pm-9pm Seth Yoo
Wednesdays 7:30pm-9pm Javier Gutierrez Bach
Thursdays 6-7:30pm Javier Gutierrez Bach, 7:30-9pm Seth Yoo

Some other ideas to help you learn this material

If what you're doing isn't getting you the results you want (you're not happy with your grade on an exam, you're stuck on a homework problem, confused about a concept, etc), the next logical step is to try doing something different! If you're trying a new strategy or study technique, it's usually more effective to pick one or two new things at a time to test them out rather than to completely change everything.

Inside of Class

Since school during lockdown had a mix of delivery styles and many students report their attention spans and ability to engage in lecture has gone down in recent years, here is some advice on how to get the most out of our time in class together:

- Eliminate distractions as best you can while you participate in class and work on this course outside of lecture.
  - Our brains are not usually physically able to "multitask," i.e. do multiple things in parallel. Instead, our brains switch very quickly between tasks and we feel like we are magically doing them at the same time when we're not. This means when you have multiple things going on when you are trying to learn a new thing, your brain cannot as easily store things you're learning in your long-term memory even though you feel like you are paying attention. For peer reviewed research about this in the study of cognition, see *Mayer and Moreno 2003*, *Junco 2012*, and *Junco and Cotten 2012*.
- Take notes during class, and as soon as you can after class summarize or outline the notes for yourself in a separate document.
- Work problems along with the lecture, even if you are going through your notes later. You get more out of doing math than you do watching math!
- Answer questions I ask in class, even if you're not confident your answer is correct! Talking through things is a good way to clarify ideas.
- Ask questions throughout the lecture!
- If you are unable to attend lecture at the normal time, get class notes from your classmates, write down questions you have, and email them to me.

Outside of Class

Regularly check both your Amherst email address and the course Moodle page to keep informed of any announcements, deadlines, assignments, syllabus adjustments, or policy changes made during scheduled classes.

This class and the math department have many resources for you to help you succeed. Your first resource is other students in the class; studying with your group (or forming your own study group) and quizzing each other is an excellent way to clarify your thinking and get new ideas. Secondly, there are many office hours for you to attend. Office hours are times set aside for

students to drop in, ask questions, and work through material with other students. There are TAs assigned to this course as well as QFellows with regular office hours. The QCenter is also open regularly for drop in help. Finally, I have office hours and am available by email.

Some other things to try:

- Come to office hours regularly, even if you don't have your own question! Someone else might ask a question that is relevant to you.
- Summarize or outline the definitions, propositions, theorems, and conjectures for yourself while you are reading the text.
- Try to solve problems from class for yourself without looking at the lecture notes, then, compare the solution you came up with to the solution we did together or you found in the book! Even if your solution is very different or you could not finish it your way, you will likely learn a lot from the experience. This is the math equivalent of lifting weights with a spotter!
- Discuss ideas from class with your peers in a respectful way, making sure everyone involved in the conversation is able to speak and work through problems together.
- Google strategies for succeeding in mathematics classes! There are many problem-solvers in the world, and we all have different perspectives on how to effectively learn mathematics and communicate it in a useful way.

Required Text

A Course in Linear Algebra by David B. Damiano and John B. Little. Copies of the textbook and its solution manual are on reserve in the Science Library.

Other texts which might be useful

Book of Proof, 3rd edition, by Richard Hammack,
Linear Algebra and Its Applications, any edition, by David Lay, Steven Lay, and Judi McDonald.
Teach Yourself How to Learn: Strategies you can use to ace any course at any level by Saundra Yancy McGuire.

Add/Drop

It is very difficult to catch up in a math class if you miss classes, even the first couple of days of the semester. We will start out the semester with some tricky, abstract ideas and trying to catch up if you miss the topics the first time in class is unnecessarily difficult. I strongly suggest that you attend every class the first week, including the first day, if you're interested in adding this class.

The Amherst College Honor Code

The Amherst College Honor Code applies to this course. It is your responsibility and mine to be familiar with and uphold *all aspects* of this code, including the Statement of Intellectual Responsibility, the Statement of Respect for Persons, the Statement of Freedom of Expression and Dissent, and the Statement of Student Rights.

How to earn a specific grade in this class

Your final grade in the class will be computed by:

Homework	16%
Check-In Quizzes	5%
Midterm Exams	54% (18% each)
Final Exam	25%
Extra Credit	up to 3%

The most important factor in your final grade in this class is your actions! You are capable of any of the following grades, and if at any point in the semester you are not getting the grade you want, try changing something you are doing. Passing grades will follow the scale:

A+	[98%-100%]	C+	[77%-80%)
A	[93%-98%)	C	[73%-77%)
A-	[90%-93%)	C-	[70%-73%)
B+	[87%-90%)	D	[60%-70%)
B	[83%-87%)		
B-	[80%-83%)		

A final course grade of less than 60% will most likely result in a final letter grade of F. Curving is at my discretion, and if it happens will only happen at the end of the course once all assessments have taken place.

Special arrangements

Extensions and Make-Ups

If for some reason you cannot hand in your homework in time or take a check-in quiz in time, you can request up to TWO extensions during the term with no questions asked. You must contact me no later than the day before the due date to let me know. If you have a religious holiday on the same date as an exam in this course, let me know within the *first two weeks of the semester*.

Accommodations

I strive to support all students so please come meet with me if you have any questions or concerns about your engagement and success in this course. Students seeking general disability services and/or accommodations should contact Accessibility Services. You can reach them via email at accessibility@amherst.edu, or via phone at 413-542-2337. Once you have your accommodations in place, I will be glad to meet with you privately during my office hours or at another agreed upon time to discuss the best implementation of your accommodations. For more information, please visit the Accessibility Services website.

What we'll be learning about and when

The following schedule is tentative and may shift slightly as the semester develops. Nothing will be made due earlier than indicated but some things may be pushed back or eliminated altogether, depending on time. All changes will be announced in class and posted on Moodle.

Week	Topics we'll explore
Week 1	- Review on your own: Vectors in $\mathbb{R}^2$ (the plane) and $\mathbb{R}^3$ (3 dimensional space) and operations on them like vector addition and subtraction - Chapter 1.1: Vector spaces
Week 2	- Chapter 1.2: Subspaces - Chapter 1.3: Linear combinations - Midterm Exam 1: Friday, February 9 - covers 1.1 and 1.2
Week 3	- Chapter 1.4: Linear dependence and independence - Chapter 1.5: Solving systems of linear equations - Pg 20 and 21: Matrix sum, scalar product

Week 4

- Row reduction and echelon form
- Chapter 1.6: Bases and dimension
- Span of vectors, row and column space
- Chapter 2.1: Linear transformations
- Chapter 2.2: Linear transformations between finite dimensional spaces
- Representing linear transformations as matrices

Week 5

- One to one and onto functions
- Matrix multiplication and systems of equations, matrix-vector form $A\mathbf{x} = \mathbf{b}$, transpose of a matrix
- Chapter 2.3: Kernel and image

Week 6

- Chapter 2.4: Applications of the Dimension Theorem
- Chapter 2.5: Composition of linear transformations
- Midterm Exam 2: Friday, March 8

Week 7

- Chapter 2.6: The inverse of a linear transformation
- Matrix inverse
- Chapter 2.7: Change of basis
- Coordinate systems, similarity

Week 8

- Chapter 2.7: Change of basis
- Chapter 3.1: The determinant as area
- Chapter 3.2: The determinant of an $n \times n$ matrix

SPRING BREAK

Week 9

- Chapter 3.3: Further properties of the determinant
- Chapter 4.1: Eigenvalues and eigenvectors

Week 10

- Chapter 4.2: Diagonalizability
- Midterm Exam 3: Friday, April 12

Week 11

- Chapter 4.3: Geometry in $\mathbb{R}^n$

Week 12

- Chapter 4.4: Orthogonal projection and the Gram-Schmidt process
- Chapter 4.5: Symmetric matrices

Week 13

- Chapter 4.6: The spectral theorem

Week 14
- Wrap up

Important Dates

January 29	First Day of Classes
February 7	Last Day of Add/Drop
February 9	Exam 1
March 8	Exam 2
March 18-22	Spring Break
April 12	Exam 3
April 15	April Break
May 6	Last Day of Classes
May 8	Make Up Day
May 13-17	Final Exams

This syllabus provides a general plan for the course; deviations may be necessary. You are responsible for all of the information in this syllabus, so please read it carefully and refer back to it regularly.