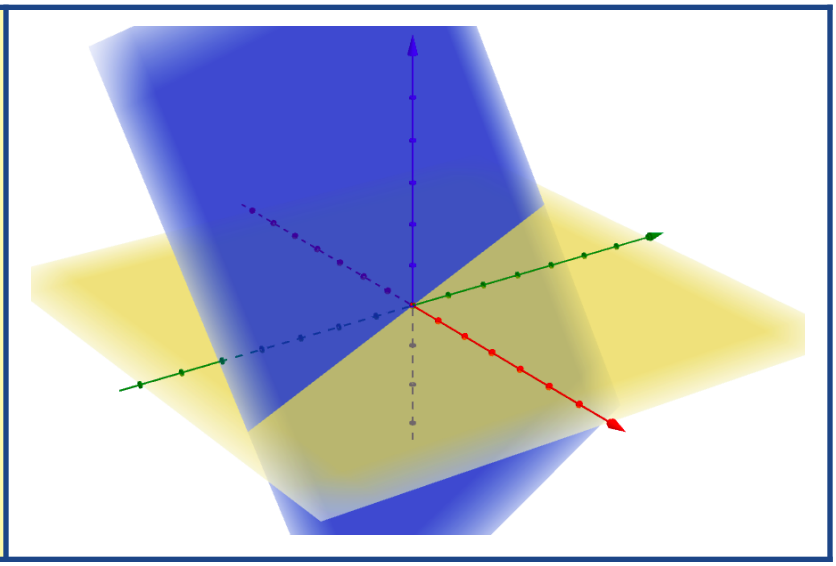
Math 33A:

Linear Algebra and Applications

UCLA
Fall 2022 Syllabus

Lecture 2: MWF 9-9:50am in Bunche Hall 2209A



Course at a Glance

Instructor: Dr. Christy Hazel (she/her/hers) | *Email*: chazel@math.ucla.edu | *Office*: MS 6304

Teaching Assistants: See Bruin Learn for TA info and office hours.

Student Hours (also known as "Office Hours"): **Mondays 10:30-11:30am** in person (these will be in my office in Week 1 and then in a room TBA) and **Wednesdays 5:30-6:30pm** on Zoom (find the link on Bruin Learn)

Course Description: Everyone knows mathematics studies "equations", but what does it mean to study "equations" and what can we gain through this study? In this course you will learn about systems of linear equations, one of the most useful and widely applicable families of equations. Linear systems arise in many real-world situations, ranging from modeling in physics to machine learning to weather forecasting; it's impossible to overstate their usefulness in modern society. In this class you will learn how to encode systems of linear equations into the powerful form of $A\vec{x} = \vec{b}$ and learn efficient ways to solve them. You will learn how the tools needed to solve these systems fit into the rich mathematical world of "vector spaces" and "linear transformations", and see how to apply these tools in a variety of situations.

Textbook: O. Bretscher, *Linear Algebra*, 5th Ed., Prentice Hall.
It's fine if you have an earlier version of the textbook, but note homework will be assigned out of the 5th edition, so you will need to find a way to access the homework problems. You can get the textbook from the bookstore, but you can also get it elsewhere (either a physical or electronic version) if you prefer.

Other stuff you'll need: You will need access to a computer and stable internet to complete some of the assignments. You do not need a calculator.

Prerequisites: Math 31B, 32A, or 3B.
While calculus content will not be explicitly used in this course, the study skills you developed in your calculus classes will help you succeed in this course.

Contents in this Document

Grading Scheme: How Your Learning Will Be Assessed

Grading scheme: Your letter grade will be assigned based on the following weighted average.

Pre-class assignments	5%
Discussion group work	5%
Homework	10%
Learning outcome quizzes	63%
Final exam on Sunday, Dec. 4th	17%

Standard letter grade assignments will be made (93 or higher is an A, 90–92.9 is an A−, 87–89.9 is a B+, 83–86.9 is a B, 80–82.9 is a B−, 77–79.9 is a C+, etc). The grade of A+ will be awarded in exceptional situations.

This class will not be graded on a curve. In particular, your grade will not be determined by the performance of your peers, but rather on your ability to demonstrate mastery of the learning outcomes and your engagement with the course based on the scheme presented above. However, if I determine that an assessment was too difficult or not representative of student learning, then I will adjust everyone's grades accordingly. Adjustments are unlikely and will only

ever benefit students (for example if you earn an 85% with the above scheme, then you are guaranteed at least a B in the course). I will clearly communicate any adjustments to the class.

Communication: How to Contact Us

Here are a few ways you can contact us if you have any questions or concerns about the course.

- **Student Hours:** If you have math questions, you are encouraged to come to Student Hours/Office Hours.
  - *This is our designated time to help you!* I like to call these "Student Hours" instead of "Office Hours" to emphasize these are my scheduled hours to interact with students from this class.
  - Come by for any amount of time during these scheduled hours.
  - While it's often more productive if you come with a specific question, you are also welcome to come listen to other students' questions and/or quietly work on assignments and then ask questions as they pop up.

- **Campuswire:** A Campuswire is set up for this course (see Bruin Learn for how to access it), and you can use this messaging board to ask any mathematical questions outside of class and student hours. You can post as yourself or post anonymously. Other students, the TAs, or I can then answer your question or provide some hints to get you started. Even if you don't have questions, I encourage you to regularly check the Campuswire to read other students' questions and responses.

- **Email:** You can also email your TA or me (chazel@math.ucla.edu).
  - While I love talking with students, there are 200+ students in this class, so I will need to prioritize answering questions that cannot be answered by reading the syllabus, reading the FAQ on the course page, or asking your TA. In order to resolve your issue as quickly as possible, try those resources first. Then if you still have a question, email me and include what you searched for in the syllabus (Ctrl-f is very helpful!), your TA's response, and then what you still need clarification on.
  - Make sure to include "MATH 33A" in the subject. Also include your name, your section, and your student ID number either in the body of the email or in your signature.
  - We will try to respond to emails within 1–2 business days. You should not expect any email responses after 5pm or on the weekends.
  - If you aren't sure how to properly email professors, here's a helpful article that can be applied in all of your classes.

Classroom Culture and Expectations

This class is built on the belief that anyone can learn mathematics. While you all have the ability to learn the topics in this course, I recognize that you all come to class with your own set of challenges, responsibilities, and pressures that might affect whether you can participate to the best of your abilities in the classroom. Thus it is essential that we all work to create an inclusive and productive learning environment. Here are a few specific things you and I can do to build and maintain this environment.

- ➔ **Be present.** We have a limited amount of time together in the classroom, so let's use this time productively. For all of us, this means showing up on time, being ready to start at the beginning of class, and keeping distractions (cell phones, non-course related materials, etc.) to a minimum.

- ➔ **Recognize that learning is a process and be open to making mistakes.** I do not expect you to be able to do every homework or worksheet problem on your first try. Be open to trying new problems and making mistakes. Recognize that mistakes are a natural part of learning, and find something to learn from your mistakes. With that said, if you find yourself stuck on a problem for a long time without making progress, reach out to your peers, TA, or me to get some guidance.

- ➔ **Listen to understand, not to judge.** In lecture and in discussion, you will often be discussing mathematics with your classmates. Make sure everyone in your group gets a chance to share ideas, and listen to understand and learn from your classmates' ideas, not to judge their abilities. If you disagree with something, share your disagreement respectfully and make sure you are critiquing the ideas and not the person.

Learning Outcomes

These learning outcomes break down what you will learn to do in this course. They are organized into seven categories.

Vector operations and properties of subsets of vectors

- ★ Perform the basic vector operations in $\mathbb{R}^n$: addition, scaling, and dot product.
- ★ Determine if a given vector in $\mathbb{R}^n$ is a linear combination of a given list of vectors in $\mathbb{R}^n$.
- ★ Determine if a given subset of vectors spans $\mathbb{R}^n$, is linearly independent, and/or is a basis for $\mathbb{R}^n$.
- ★ Be able to compute and interpret coordinate vectors as well as compute the change of coordinate matrix.

Linear equations and Gauss-Jordan elimination

- ★ Find a system of linear equations to model a given real world situation.
- ★ Translate between a system of equations, an augmented matrix, and a matrix equation.
- ★ Use row operations to put a matrix into reduced row-echelon form (rref) and recognize when a given matrix is not in rref.
- ★ Use the rref of a matrix to describe the solution set of a system of linear equations.

Linear transformations

- ★ Determine if a function from $\mathbb{R}^n$ to $\mathbb{R}^m$ is a linear transformation, and if it is linear, find the corresponding matrix.
- ★ Multiply matrices and understand how matrix multiplication is related to function composition.
- ★ Be able to determine whether or not a matrix is invertible, find the inverse of a matrix when it exists, and relate this to function inverses.
- ★ Describe the image and kernel of a linear transformation and use the rank of the corresponding matrix to describe properties of the image and kernel.

Subspaces and their bases

- ★ Determine if a given subset of vectors in $\mathbb{R}^n$ is a subspace.
- ★ Explain what is meant by the dimension of a subspace of $\mathbb{R}^n$ and apply basic properties of the dimension.
- ★ Find bases for the image and kernel of a linear transformation and use this to verify the rank-nullity theorem.

Orthogonality

- ★ Find and geometrically interpret orthogonal projections.
- ★ Use the Gram-Schmidt algorithm to find an orthonormal basis of a subspace.

Determinants

- ★ Be able to compute determinants using row operations and properties of the determinant.
- ★ Interpret the determinant as a change in area/volume.

Eigenvalues, eigenvectors, and diagonalization

- ★ Compute the eigenvalues and eigenvectors of a matrix, and interpret their geometrical significance.
- ★ Compute the eigenspaces of a given matrix and use this information to determine if a given matrix is diagonalizable.
- ★ Find the SVD of a matrix and interpret the singular values in terms of the maximum and minimum length of the image of a unit vector.

The Learning Process and More on Assessments

In order to learn a new topic, you must revisit the same material over several days. The different assignments and content delivery methods in this course break this up for you in a manageable fashion, where the level of understanding expected from you increases in each step. This is explained in the following table.

1) Pre-class assignments	2) In-class activities	3) Group worksheets
This is your first encounter with the new topic. You will read a few pages from the textbook and answer some basic reading comprehension questions. You will not be asked to apply material at this stage. It is likely you will be confused and have some questions. That is okay!	Class time will have a combination of lecture, individual work, and group work that will build on and clarify what you saw in the pre-class assignment. You will see examples and be able to ask questions. You should leave with a better understanding of the material, but you will probably still have some questions at this point.	This is your first chance to apply what you've been learning. You will work on problems with the help of your peers. The TA and LAs will provide hints and answer clarifying questions. At this stage, you should begin to see how to apply concepts and make connections.
4) Homework	**5) Preparing for learning outcome quizzes**	**6) Learning outcome quizzes**
Homework is your opportunity to really start applying the ideas and completing problems on your own. You will likely not know how to solve every problem on your first attempt. That is okay and expected! Start early so you can make many passes through the assignment and seek help as needed. By submission time, you should have a good grasp of the material.	You should revisit old homework problems, readings, and class notes. Discuss with your peers, your TA, and me. Take the time to fill in any gaps you missed. Carefully read any feedback given on your homework or first attempt (if applicable). Ask questions and challenge yourself by trying new problems.	At this stage, you will have had several opportunities to engage with and learn the material. You should feel confident about the outcome before taking the quiz, and this is your time to demonstrate what you learned. *Note: If you don't pass on your first attempt, then return to (5), reflect, and try again.*

More on Assessments

Pre-class assignments

On lecture days (MWF), you will have a short reading assignment due at 11:59pm the day before (SuTuTh). You can find these on Bruin Learn. You can attempt these assignments as many times as you want before the deadline, and only your highest score will be kept.
Your 6 lowest pre-class assignments will be dropped.

Discussion group work

At the beginning of the term you will be placed in a team of students from your discussion section. During each discussion you will work with your group on a worksheet related to the learning outcomes we are discussing in lecture that week. You will turn in the worksheet at the end of discussion and receive a grade based on completion.
Your 3 lowest worksheet scores will be dropped.

Homework

Starting in Week 2, you will have a homework assignment due every Wednesday at 11:59pm. You will find the assignments on Bruin Learn and submit them on Gradescope. Late won't be accepted (see more about late work policy below).
Your lowest two homework assignments will be dropped.

Learning outcome quizzes

The main way to earn points in this class is to complete learning outcome quizzes to demonstrate you have mastered one of the learning outcomes from this course. Every time you pass a learning outcome quiz, you earn 3% towards your final grade. There are 22 total outcomes, and can earn up to 63% of your grade this way (so you can miss one outcome without your grade being affected). You can find these quizzes and more information on BruinLearn.

Note there will be no partial credit on these assessments. These will be graded on a scale given by

> **Success!**: you have demonstrated mastery of this outcome and receive full credit; or
> **Not yet**: you have not yet shown mastery of this outcome and still need to do some work on it. No credit will be awarded at this time.

If you receive a "Not yet" on one of your outcome quizzes, then you will be able to retake another version of the quiz. You should carefully read any feedback we gave on your attempt, review the relevant material, and reflect on what went wrong before trying again.

Reflection is a key part of the learning process. When you resubmit, you will be required to submit a short "reflection paragraph" in which you reflect on what you misunderstood the first time you took the quiz and how you were able to clear up these misunderstandings.

Final exam

We will have a cumulative final exam on **Sunday, December 4th from 11:30am–2:30pm**, location TBD. I will share more details about this exam towards the end of the course.

Late Work Policy

I recognize that life can sometimes get in the way of submitting assignments on time. Unfortunately with the number of students in this class, it just isn't possible to coordinate extensions and late work. It's also better for your success in the class to just look over what you missed, and then focus your attention on upcoming assignments instead of trying to make up small assignments you missed. Instead of late work, each assignment category has some number of dropped assignments so that you can miss occasional assignments without your grade being impacted. You can miss up to two weeks of low-stakes assignments without any penalty.

The official course policy is that no late work will be accepted and no extensions will be given. But if something comes up that is causing you to miss more than two weeks of course assignments, then you should contact me so we can discuss your options in the course.

Student Resources for Support and Learning

Below are just a few of the resources offered by UCLA that could be helpful for you. UCLA has a lot of resources available, so it can be hard to stay informed about all of them. The link https://www.studentaffairs.ucla.edu/student-services has more information on resources.

Computers on Campus

You will need a computer to complete the pre-class assignments, the learning outcome quizzes, and to submit your homework assignments to Gradescope. UCLA has a few computer labs on campus that are available for you to use for free as a student. You can visit https://www.library.ucla.edu/use/computers-computing-services/computers-library for information about computer access through the library.

Academic Accommodations Based on a Disability

Everyone in this class deserves an equitable opportunity to learn and engage with the material. If you are already registered with the Center for Accessible Education (CAE), please request your Letter of Accommodation in the Student Portal. If you are seeking registration with the CAE, please submit your request for accommodations via the CAE website. Students with disabilities requiring academic accommodations should submit their request for accommodations as soon as possible, as it may take up to two weeks to review the request. For more information on available accomodations, please visit the CAE website (www.cae.ucla.edu), visit the CAE at A255 Murphy Hall, or contact them by phone at (310) 825-1501.
You are also welcome to come talk to me about any accommodations that you may need, whether or not you are registered with the CAE.

Counseling and Wellness

Whether you are dealing with symptoms of stress or depression, have experienced a traumatic event, or would just like someone to talk to, Counseling and Psychological Services (CAPS) at John Wooden Center West offers support for your mental health needs in various forms. For more information visit www.counseling.ucla.edu. The Crisis Line at (310) 825-0768 is available 24 hours a day, 7 days a week, including holidays.

Title IX Information

Title IX prohibits gender discrimination, including sexual harassment, domestic and dating violence, sexual assault, and stalking. If you have experienced sexual harassment or sexual violence, you can receive confidential support and advocacy at the CARE Advocacy Office for

Sexual and Gender-Based Violence, 330 De Neve Dr., CAREadvocate@careprogram.ucla.edu, (310) 206-2465. In addition, Counseling and Psychological Services (CAPS) provides confidential counseling to all students and can be reached 24/7 at (310) 825-0768. You can also report sexual violence or sexual harassment directly to the University's Title IX Coordinator, 2241 Murphy Hall, titleix@equity.ucla.edu, (310) 206-3417.
Reports to law enforcement can be made to UCPD at (310) 825-1491.

Note faculty and TAs are mandatory reporters. This means we are required under the UC Policy on Sexual Violence and Sexual Harassment to inform the Title IX Coordinator should we become aware that you or any other student has experienced sexual violence, sexual harassment, or other prohibitive conduct.

Academic Integrity

All of you have worked hard to become students at UCLA, and you bring valuable and unique skills to the classroom. Unfortunately, the structure of college, especially in STEM courses, is often hyper-competitive, which can cause anxiety and make you feel isolated. Such feelings can make it seem like plagiarism is your only way forward. Despite that feeling, academic dishonesty is never the answer and it harms everyone in our learning community. It negates the work of the person whose answers were copied, it devalues the work of your peers that submitted their own ideas, and it misleads me to think more of the class understands a concept than really does.

Sometimes there's confusion about what counts as academic dishonesty in a math class. So to be clear, here are some examples. All of these would be considered cheating in this course.

- Looking up homework questions online and copying the work/answer on your own assignment.
- Looking up homework questions in a solutions manual and copying the work/answer on your own assignment.
- Collaborating on the learning outcome quizzes (*you can collaborate on homework, but not on quizzes or exams*).
- Looking up the learning outcome quiz questions online and then copying the work/answer on your own assessment.
- Posting homework or learning outcome questions online and soliciting help.
- Copying a homework solution from one of your classmates. (*Note you **are** encouraged to work on homework together, but you must write up your own solutions in your own words.)*

The above are just some examples of cheating. See the UCLA Student Conduct Code for a more complete description of academic dishonesty. If you're ever unsure if something counts as cheating, ask me or a TA first. There is no penalty for asking.

Here are some alternatives to academic dishonesty for when you are feeling overwhelmed:

- **Communicate with someone in the class** and ask for homework help. See the section Communication: How to Contact Us for more information.

- **Seek support through UCLA resources**. See the section Student Resources for Support for more information.
- Lastly, if you're just feeling overwhelmed and do not know how to proceed in the course, reach out to me or your TA, and we'll come up with a plan.

Class Schedule

This is a tentative schedule and likely to change. See Bruin Learn for an up-to-date schedule.

Week	Date	Topics covered (textbook section(s))	Notes
0	**F 09/23**	Introductions, course overview	*No discussion meetings this week, do Team Survey on Bruin Learn*
1	**M 09/26** **W 09/28** **F 09/30**	Solving systems of equations, matrices (1.1,1.2) Row reduction, describing solutions (1.2, 1.3) Linear transformations (2.1)	
2	**M 10/03** **W 10/05** **F 10/07**	Linear transformations (2.2) Matrix multiplication and composition (2.3) Matrix inverses and function inverses (2.4)	*First homework is due Wednesday at 11:59pm*
3	**M 10/10** **W 10/12** **F 10/14**	The image and kernel of a transformation (3.1) Subspaces (3.2) Bases, linear independence, spanning (3.2)	
4	**M 10/17** **W 10/19** **F 10/21**	Dimension (3.3) Change of coordinates (3.4) Orthogonality and orthogonal projections (5.1)	
5	**M 10/24** **W 10/26** **F 10/28**	The Gram–Schmidt process (5.2) QR-factorization (5.2) Orthogonal transformations/matrices (5.3)	*Do Mid Quarter Survey on Bruin Learn*
6	**M 10/31** **W 11/02** **F 11/04**	Least–squares and data fitting (5.4) Determinants and their properties (6.1, 6.2) Determinants and their properties (6.1, 6.2)	
7	**M 11/05** **W 11/09** **F 11/11**	Geometric properties of the determinant (6.3) Diagonalization (7.1) **No classes (Veterans Day)**	
8	**M 11/14** **W 11/16** **F 11/18**	Finding eigenvalues and eigenvectors (7.3) Dynamical systems (7.4) Complex eigenvalues (7.5)	

9	**M 11/21** **W 11/23** **F 11/25**	Symmetric matrices (8.1) Quadratic forms (8.2) **No classes (Thanksgiving break)**	
10	**M 11/28** **W 11/30** **F 12/02**	Singular values (8.3) Review, summary, catch up Review, summary, catch up	*Do course evaluations through MyUCLA*
11	**Su 12/04**	**Final exam 11:30am–2:30pm**	