Course Description

A matrix is a way that mathematicians and computer scientists keep track of large amounts of data, especially data that has multiple attributes or dimensions. In this class, we will use matrices (the plural of matrix) to solve systems of linear equations. We will study the abstract forms of these systems of equations as well as their applications to science, engineering, and economics. There will be an emphasis on the algorithms needed to solve these problems, but also on why these algorithms work.

Here are some examples of problems we will study this semester.

- Given a network representing flow in and out of a set of nodes, set up a set of linear equations that models the network and find a solution that represents a state of equilibrium.
- Given a collection of data how do we find a quadratic function which best fits this data using the least squares method?
- Given a matrix that represents an image in computer graphics software, how can we reflect, rotate or otherwise transform the image?
- Given a network of websites how do we rank a set of search results so that the most relevant results appear first?

Another important theme in this class is the idea of the existence and uniqueness of a solution. Up until now, many of the problems you have encountered in your math classes have been carefully constructed by your teachers to ensure they always have exactly one correct solution. However, in the wilderness outside your math classroom, this will not always be the case. Some problems will have no solution, while others will have more than one solution. In this class, we will study the properties of systems of linear equations and how to tell if a system has a unique solution.
Learning Goals for Math 33a

Here is a more technical description of our learning goals for this class.

Content Learning Goals

By the end of the semester, students will master the following content goals:

- Solve systems of equations using matrices.
- Characterize systems of equations whose solutions exist and are unique, and relate this to the rank and nullity of a matrix.
- Use matrices to express linear transformations.
- Calculate the kernel and image of a linear transformation.
- Determine if a set of vectors is linearly independent or spanning.
- Calculate determinants and inverses of matrices.
- Interpret the determinant of a matrix in terms of the change in volume in a linear transformation.
- Calculate eigenvalues and eigenvectors and articulate their algebraic and geometric interpretations.
- Find the singular value decomposition (SVD) of a matrix.
- Apply knowledge about matrices and linear transformations to a broad range of scientific and economic problems.

Metacognitive learning goals

In addition, students will also practice the following skills:

- Convey complex mathematical ideas clearly and succinctly using both oral and written formats.
- Apply logical thinking and problem solving skills to material in ways not demonstrated explicitly in class.
- Cooperate in groups with other students.

Structure of Course

To help you master these goals, the course will have the following structure/requirements.

Grading

Your grade in the course will be based on a final score given by the maximum of the following two schemes:

Scheme 1 Default

- Pre-Class Quizzes (15% of your grade)
- Groupwork (10% of your grade)
- Written Homework (10% of your grade)
- Two midterm exams (each 20% of your grade)
- Final exam (25% of your grade)

Scheme 2 Drops lowest midterm and scales everything else up accordingly

- Pre-Class Quizzes (18.75% of your grade)
• Groupwork (12.5% of your grade)
• Written Homework (12.5% of your grade)
• Maximum of 2 midterm grades (25% of your grade)
• Final exam (31.25% of your grade)

Flipped Course

This is a flipped course, meaning that course content will be delivered through reading and pre-recorded videos. You must watch the videos and complete the online pre-class quizzes by 6am Pacific Time before each class period.

Lecture time will be a time to go over example exercises and answer questions. You can post your questions on our class discussion forum on CCLE and the instructor will answer them during the lecture period.

If you cannot attend the lecture meetings (our Mon-Wed-Fri meetings), then it is even more important that you do the pre-class assignments and post questions on the class forums as this will be the main way for you to learn new material. All our Mon-Wed Fri meetings will be recorded, so it is possible to do well in this class without attending all these Zooms, but you must watch the videos and participate in the pre-class quizzes and forums.

Team learning

You will be assigned a group of classmates to work with, your team. Each week there will be a team assignment. You can either complete your team assignment during your team’s assigned discussion section or you can arrange to meet with your teammates at some other time. If you do not plan to complete your team assignment during your discussion section please let your TA know when you plan to meet with your team, and turn your assignment in shortly after. You must meet with your team and complete the assignment together. You should designate one person on your team to turn in your assignment. Team assignments will be graded for effort and completion.

You must complete the Pre-Course Survey in order to be assigned to an appropriate team.

Homework

Each week there will be a short written assignment to be turned in over Gradescope. Unfortunately we do not have the resources to grade every HW problem so each week, 2-3 problems will be randomly chosen out of the assigned exercises and those will be graded.

Exams

All exams will be given online over Gradescope. You will have a 24 hour window to complete the exam starting at the time given below. All exam work must be done individually.

• Midterm 1: Friday October 30, 8am Pacific Time
• Midterm 2: Friday November 20, 8am Pacific Time
• Final: Sunday December 13, 11:30am Pacific Time

Other important logistics and policies

Prerequisites

MATH 3B, 31B or 32A or equivalently at least two courses in calculus at another university. Students are expected to be familiar with vectors and basic matrix algebra, including calculating determinants of $2 \times 2$ matrices.
Technology Requirements

This course will be entirely online. All class meetings, including lectures and discussion sections will take place over Zoom. Exams will be administered online and all assignments will be assigned and turned in either through CCLE or through Gradescope.

In order to succeed in this class you will need the following technology.

- Consistent access to a internet connection stable enough to watch videos.
- A way to attend zoom meetings, either through the internet or through a phone connection.
- A way to draw on PDF documents. This might be printer, a pen or pencil and scanning app on your phone, or it could be a tablet and stylus that allows you to draw directly on a PDF. All assignments must be uploaded in PDF format.
  - If you don’t have a printer and would prefer to hand write HW and exam problems on blank paper, that’s fine, but you must copy the entire question. For example if you are doing exercise 2 on an exam, it is not enough to just write “2)” and then your solution. You should also copy out the statement of the question.
  - Also, be sure to give yourself at least as much space as is given in the pdf of the exam. For example if the pdf of the exam questions includes an entire page worth of space for you to write your answer and your hand written answer is only a quarter of a page, you are probably missing part of the answer.
  - Here is more information about how to scan and upload your homework.

If you don’t have all of the above here are some resources to help.

- Bruin Tech Fund (undergraduates only):
  https://www.financialaid.ucla.edu/Portals/84/publications/UCLA%20Bruin%20Community.pdf
- UCLA IT Services - Helping Students Stay Connected at Home:
  https://www.it.ucla.edu/news/helping-students-stay-connected-home
- UCLA Library Information and Resources:
  https://www.library.ucla.edu/covid-19-response-library-information-resources

More Resources

- Your Peers! Don’t underestimate the value of your classmates, they can help you, and when you help them, you will learn too!
- Class forums on CCLE We will have regular places for you to post questions on CCLE. You can post anonymously and you can also upvote others questions. I will anser these questions during the recorded lecture period. This is a great way to get your question answered and let other students benefit too!
- CampusWire This is another forum for you to post questions on. You can also answer your classmates questions and like others questions or comments. CampusWire rewards you for answering each others questions and makes it a bit like a computer game. There are also chat rooms where you can talk to your classmates and see if anyone else online happens to be stuck on the same question. I will sometimes post answers to posts on CampusWire, but only if the question has gone unanswered for a while as I want to encourage you all to answer each other.
- Class videos All class meetings will be recorded and uploaded to CCLE so you can watch them again!
- Instructor and TA office hours This is the time that we set aside for you to ask ANY questions you have, take advantage of it.
- SMC- Student Math Center Free tutoring the students in UCLA math classes. Open for drop in hours Mon-Thurs 9am-3pm.
• **Our textbook** It has more than just HW problems in it! I recommend you focus on reading the example problems and solutions. Take notes and quiz yourself along the way asking yourself why the author chose to do each step.

**Emails**

You are strongly encouraged to post any questions to the Hot Questions forums on CCLE or the CampusWire, rather than emailing your instructor. Note you can post anonymously.

**Recording**

All Mon-Wed-Fri class meetings will be recorded, and the recordings will be posted on CCLE. Recordings will not be posted in a public place, but if you turn on your camera or speak aloud in class it is possible that you will appear in the recording. If you do not feel comfortable being on the recording you can

- Ask your question in the chat and one of the LA student assistants will read it aloud anonymously
- Ask your question on the CCLE forums or Hot Questions.

Discussion sections and meetings in breakout rooms are not recorded.

Recording anything that shows your fellow student or sharing any of our class videos on platforms not protected by your UCLA login is expressly forbidden. This is a university wide policy that helps us be compliant with federal law, so please take it seriously and do not share class videos on public forums.

**Attendance and accommodations for students in different time zones.**

Attendance at our Mon-Wed-Fri lectures is recommended but not required. All required information will be contained in the prerecorded videos.

Attendance at your discussion section is strongly recommended! If you cannot attend your scheduled discussion section you should indicate this in your Pre-term survey and you will be assigned to a team of classmates who have similar issues. You will be able to arrange a separate time to meet with your teammates and complete assignments.

**Late/Missed assignments**

I generally don’t accept late homework or give extensions on assignments. I will drop 30% of a particular category, so for example if there are 10 HW assignments in the term I will drop the lowest 3 grades. I will also drop 30% of the pre-class assignments and group assignments.

Note that outside of the pandemic, I usually drop 20%, so upping this number is part of how I am accounting for special circumstances this term, in a way that applies to all students.

If you have some sort emergency that you expect will prevent you from attending class or doing assignments for two or more weeks please contact your instructor immediately. However if the period of time you will need to miss is one week or less you should just take the zeros and know they will be dropped at the end of the term. It is my experience that this policy is actually more beneficial for students than giving extensions or make-ups as extensions and make-up exams can often cause students to fall even further behind.

**Honor Code**

Exams will be open note and open book. However during the 24 hour period when you take the exam, you are not permitted to communicate about the exam or the class material with any of your classmates or post any of the questions on the internet. You will be asked to sign a honor code attesting to the fact that your work on the exam is solely your own.
Accessibility

If you are a student who needs academic accommodations because of a documented disability you should present your letter of accommodation to your instructor as soon as possible. You will need an official letter from UCLA Center for Accessible Education.