Math 21 Syllabus

Summer (Session B) 2021

Instructor Information

Instructors	*Email*	*Office Location & Hours*
David Rubinstein (he/him/his) (instructor)	*darubins@ucsc.edu*	*OH: W 12-1 and F: 12-1*
Sam Johnson () (TA)	*sjohns18@ucsc.edu*	*OH: Tuesday 11 AM Sections: T and TH 10-11 AM*

General Information

Description/Learning outcomes.

*This course is an introduction to Linear Algebra and its applications. For a longer summary of what this course will consist of, see **end of the syllabus document.** Upon completion of this course, students will be able to*

- *Write systems of equations in matrix form and apply row reduction to matrices*
- *Interpret matrix solutions in various contexts of problems*
- *Model real world phenomena using matrices and linear transformations*
- *Use matrix techniques to determine when vectors or Linearly independent/spanning*
- *Identify the connections between Linear Transformations and Matrices*
- *Verify a given Set is a Vector Space, and a given function is a Linear Transformation*
- *Compute eigenvalues/vectors of a matrix and interpret their meanings in real world contexts*
- *Form successful learning groups and collaborate successfully with peers to solve problems*
- *Develop the belief that they will succeed in a STEM field*

Course Logistics

- *I will be teaching via the same zoom link every Monday, Wednesday, Friday at our designated time (9-11:30). **The password to enter the zoom meeting is LAlecture.***
    - *Summer courses are absurdly long, so we will be taking a 10-15 minute break halfway through every class.*
- *I **will be recording all my lectures and uploading it onto canvas (will be uploaded onto the 'YuJa' subheading)**, so if you can't make some classes you can watch the uploads. I **strongly, strongly, strongly encourage all who can** attend the lectures live to do so. It will be both more beneficial to you and will hopefully decrease how weird this whole ordeal will be.*

- *Section will be run twice a week by our TA* ***Sam****. You can attend either/both of the sections regardless of which one you are enrolled in or even if you enrolled in one formally. Section will be an opportunity to work on homework-like problems and to ask additional questions.* ***Sam*** *is a wonderful TA, so I highly encourage everyone to attend section, especially since we will not have face to face classes.* ***Section times will be TBD- and posted on canvas.***

Grades

Ok let's discuss the grade breakdown: your grade will consist of homework; discussions to be completed after each class on canvas; 2 projects; and 1 final exam (not worth that much)

- *Homework (80 Points)*
  - *You will have 8 HW's due. They will be due on Monday and Friday and will each be worth 10 points. You get 2 points just for completing the homework, and then the TA and I will each grade one of the problems for the other 8 points.*
  - *The homework will be posted on Canvas under assignments and files, and you will need to take a picture of your work and post it on Gradescope.*
    - *There is a guide on how to use Gradescope under "modules" in Canvas that you can look at if you have never used Gradescope before*
  - *I* ***STRONGLY ENCOURAGE*** *you to work together on the homework! If you get an answer from someone else, that's great! Group collaboration is essential in mathematics, just mention that you got help from whomever helped you! That being said,* ***DON'T USE CHEGG!!!*** *Not only is it almost always wrong, it is not beneficial to you to just copy down an answer online; it is a very different thing than having your peer explain how to do something. If you use Chegg you will get a zero and an angry email from me.*
- *Projects (40 Points)*
  - *You will have 2 projects about applications of linear algebra throughout the quarter. You may work in groups of up to 4 people for each project.*
  - *Each project is worth 20 points.*
  - *See the "Projects" subheading in canvas under assignments for specific instructions about the project and see below for due dates regarding the projects.*
- *Discussions (30 points)*
  - *After each class you will have to complete a "discussion" question on canvas. There are 15 classes, so each discussion is worth 2 points, and you get full points just for submitting anything. Each of the discussion questions will be asking you to summarize the material we have talked about that class in your own words.*
- *Final Exam (20 Points)*
  - *We will have a final exam on the last day of class that is cumulative. I will post the exam Friday morning, and you have until midnight that day to finish it. I will be available on zoom during the normal lecture time to answer any questions about the exam. The exam will be open book/open note, but again, do not use Chegg/online resources.*

GRADE BREAKDOWN

These assignments add up to 170 points. ***We will only require 160 points for a 100%, so EVERYONE GETS 10 FREE POINTS.*** *This is to account for any missed discussion or homework assignments that will inevitably occur in such a crammed quarter. The grade breakdown will be as follows.*

- *A= 148-160*
- *A- = 144-147*

- *B+ = 139-146*
- *B= 134-138*
- *B- = 128-133*
- *C+ = 123-127*
- *C= 118-122*
- *C- = 112-117*
- *D+ = 107-111*
- *D= 102-106*
- *D- = 96-101*
- *F = Anything <96*

Course Materials

Required Materials

We will somewhat follow the free online book **Elementary Linear Algebra: An eTextbook** *by Bruce Cooperstein.* ***A pdf is in our canvas page under files. (the homeworks will be created by me and not from the book however)***

There is no homework service that will be used, but you will need to submit pictures of your homework and submit it on Gradescope that is linked on canvas.

Optional Materials

. If you would like another reference you can look at any of the following books.

- ***A First Course in Linear Algebra*** *(http://linear.ups.edu/download.html)*

- *This UC Davis course notes (https://math.libretexts.org/Courses/University_of_California%2C_Davis/UCD_Mat_67%3A_Linear_Algebra)*

- ***Linear Algebra Done Right*** *by Axler (this one is more 'mature' (ie, more proof heavy) but it's a good book in my opinion. I have a pdf of it so if anyone wants it email me)*

- ***Linear Algebra Done Wrong*** *by Treil (this was written as a tongue and cheek response to Axlers's book- It is also more mature and I've never used but some instructors swear by it) https://www.math.brown.edu/~treil/papers/LADW/LADW.html*

- ***Schaums Outline of Linear Algebra-*** *by Lipshutz and Lipson. I personally don't like this book as a primary reference, but it is very abridged and straight to the point so some people really like using it as a reference. I also have a pdf that I can send to anyone if they want it.*

Course Schedule

Week	Topic	Reading	Due Dates
Week 1	**Monday 7/26:** *Class overview. Intro to linear systems of equations. Matrices and echelon form of Matrices.* **Wednesday 7/28:** *Vectors and the space R^n. Span of a list of vectors.* **Friday 7/30** *Linear independence of vectors in R^n. Subspaces of R^n and introduction to basis.*	*Chapter 1.1-1.2* *Chapter 2.2-2.5*	***HW 1 due Friday 7/30***
Week 2	**Monday 8/2:** *Introduction of Linear Transformations between R^n and R^m, and their associated matrix.* **Wednesday 8/4:** *Product of Matrix with a vector. Addition of Matrices. Multiplication of two Matrices.* **Friday 8/6:** *Invertible Matrices and Elementary Matrices.*	*Chapter 3.1-3.5*	***Hw 2 due Monday 8/2*** ***Hw 3 due Friday 8/6*** ***Final Project Groups formed due Wednesday 8/4***
Week 3	**Monday 8/9:** *Introduction to determinants, and properties of determinants/their relationship to inverse matrices.* **Wednesday 8/11:** *Introduction to Abstract Vector Spaces: Span and Linear independence in Abstract vector spaces.* **Friday 8/13:** *Dimension of vector spaces; coordinate vectors and change of basis matrix*	*Chapter 4.1-4.2* *Chapter 5.1-5.4*	***Hw 4 due Monday 8/9*** ***Hw 5 due Friday 8/13*** ***Final Project Topic and Outline Due Friday 8/13***

Week 4	***Monday 8/16:*** *Rank-Nullity of Matrix. Introduction to Linear Transformations between abstract vector spaces.* ***Wednesday 8/18:*** *Range/Kernal of linear Transformation. Matrix of Linear Transformation and Rank-nullity Theorem for Linear Transformations.* ***Friday 8/20:*** *Introduction to eigenvalues/eigenvectors. Diagonalization of matrices.*	*Chapter 5.5* *Chapter 6.1-6.3* *Chapter 7.1-7.2*	***Hw 6 due Monday 8/16*** ***Hw 7 due Friday 8/20*** ***Project 1 due Friday 8/20***
Week 5	***Monday 8/23:*** *TBD- Hopefully Chapter 8 material (orthogonal matrices/vectors), dependent on how far we get in previous weeks.* ***Wednesday 8/25:*** ***Friday 8/27:*** *Final Exam*	*Chapter 8*	***Hw 8 due Monday 8/23*** ***Final Exam on Friday 8/27*** ***Final Project Due Friday 8/27***

Additional Information and Resources

ACCESSIBILITY:

UC Santa Cruz is committed to creating an academic environment that supports its diverse student body. If you are a student with a disability who requires accommodations to achieve equal access in this course, please submit your Accommodation Authorization Letter from the Disability Resource Center (DRC) to me privately during my office hours or by email, as soon as possible so I can assure you have the support you deserve/are entitled to. We can discuss ways we can ensure your full participation in the course. I encourage all students who may benefit from learning more about DRC services to contact the DRC by phone at 831-459-2089 or by email at drc@ucsc.edu. Operations continue via remote appointments. If you have questions or concerns about exam accommodations or any other disability-related matter, email the DRC Schedulers at drc@ucsc.edu for an appointment.

RELIGIOUS ACCOMMODATION:

UC Santa Cruz welcomes diversity of religious beliefs and practices, recognizing the contributions differing experiences and viewpoints can bring to the community. There may be times when an academic requirement conflicts with religious observances and practices. If that happens, students may request the reasonable accommodation for religious practices. The *instructor will review the situation in an effort to provide a reasonable accommodation without penalty. You should discuss the conflict and your requested accommodation with your instructor early in the term.*

TITLE IX/CARE ADVISORY:

The Title IX Office is committed to fostering a campus climate in which members of our community are protected from all forms of sex discrimination, including sexual harassment, sexual violence, and gender-based harassment and discrimination. Title IX is a neutral office committed to safety, fairness, trauma-informed practices, and due process.

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 Campus Advocacy Resources & Education (CARE) Office by calling (831) 502-2273. In addition, Counseling & Psychological Services (CAPS) can provide confidential, counseling support, (831) 459-2628. You can also report gender discrimination directly to the University's Title IX Office, (831) 459-2462. Reports to law enforcement can be made to UCPD, (831) 459-2231 ext. 1. For emergencies call 911.

Long Summary of Course material

We will begin the course with the humble study of so called "systems of linear equations." These equations are ubiquitous in the sciences, so a formal theory of how to efficiently solve them is important. In order to simplify our lives in solving these systems we will introduce the idea of a "Matrix." It turns out that a matrix is an object worth studying in and of itself and will be the topic of much of the later material of the course.

Once we have developed the algorithms needed to solve these equations, we will turn to the discussion of vectors in R^n*. This "space" is in some sense where the solutions to the linear systems "live." We will introduce the basic notions of "spanning" and "linear independence" and will relate these ideas back to the goal of solving systems of equations.*

Then we will begin our descent into the realm of abstraction: we will start studying Matrices and discuss how we add them, multiply them to a vector, and multiply two of them together. To ground ourselves, and to make sure we don't veer too far into the realm of abstraction just yet, we will relate these results about matrices back to the original question of how to solve systems of equations. The connection between matrices and systems of equations leads to the idea of a determinant; a very strange looking function that will none the less prove to be very useful and important to us.

At this point, we will be fully immersed in the abstract world, so it is a good place to introduce "abstract vector spaces." Just as R^n *was the space where solutions to linear equations lived, these vector spaces will consist of abstract vectors that in some sense "behave" like the normal vectors we have been studying (don't worry we will make this precise and it will not be scary I promise). These vector spaces are really just an algebraic generalization of* R^n*, so we will begin by redoing a bunch of what we just did in* R^n*, but now in this more general context.*

Just as the matrix was the main object of study in R^n*, a so called "linear transformation" will be what we want to learn for the rest of the course. Linear transformations are one of the most important and common functions that exist in physics, math, chemistry, computer science, etc. (for example, the Derivative, and any combination of partial derivatives, are linear transformations). In particular we will study the so-called "eigenvectors and eigenvalues" of the transformations, which in some sense represent "nice" solutions to a given physical system.*

If we have time we will end with the study of "orthogonal matrices" and "orthogonal vectors." These are super important matrices that behave basically like rotations. Applications of these range from quantum mechanics, to graphic design, to video game programing, to organic chemistry, etc.