MATH 21: LINEAR ALGEBRA
Spring 2021 SYLLABUS

INSTRUCTOR INFORMATION

Instructor: Bruce Cooperstein

Office: 4157 McHenry Library (I won't be there because of Covid-19)

Phone: 459-2150 (do not leave a message, I don't check)

email: coop@ucsc.edu

Office hours: Mondays 330 PM - 430 PM, Thursdays 100 PM - 200 PM

TEACHING ASSISTANT INFORMATION

Name: Wade Hampton
Office Hours: Tu, Th 230 pm - 330 pm
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Name: Jennifer Guerrero
Office Hours: Tu, Th 1200 pm - 100 pm
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Name: Jonathan Kay
Office Hours:Tu 1000 an - 1200 pm
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Name:Justin Lake
Office Hours: Wed 1200-100 pm, Th 1030 - 1130 am
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Name: Junwen Liao
Office Hours:
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DISCUSSION SECTIONS

Discussion 01A: M 920 AM - 1025 AM - Jennifer

Discussion 01B: F 920 AM - 1025 AM - Junwen

Discussion 01C: TU 120 PM - 225 PM - Wade

Discussion 01D: TH 920 AM - 1025 AM - Justin

Discussion 01E: M 240 PM - 345 PM - Jonathan

Discussion 01F: W 120 PM - 225 PM - Jonathan

Discussion 01G: F 120 PM - 225 PM - Junwen

LOCATION AND TIME OF LECTURES

Time of Lectures: MWF 1040 AM - 1145 AM

Check the Canvas Calendar for the links to the Lectures

Canvas

The syllabus for this course as well as all communications are to be found

on the class management system **Canvas**: Emails (from me), assignments,

surveys, practice questions for midterms and final and so on will be found

there. In addition

small group discussion groups can be organized as well as full classchat groups.

To login go to canvas.ucsc.edu. When you get there login with your email

 user name (the part the goes before .ucsc.edu). Your password is

your gold password. Note that you can go into the preferences and have

Canvas email forwarded to any preferred email address.

When you need to contact your instructor or TA, please use Canvas as email messages will **NOT** be replied. This is to make communication more efficient, so we can correctly identify your section and other important information.

PIAZZA

We will use Piazza for questions regarding HW, exams, lectures, etc.

This tool is great for collaboration and to write math. It is difficult to

type math in an email or in Canvas, so use Piazza for all content related questions!

OTHER SOURCES OF SUPPORT

SGT, **MSI** and **ACE** are additional resources that can help you with class.

You are **highly** encouraged to attend to these.

TEXT

The textbook is **Elementary Linear Algebra** by Bruce Cooperstein. It can be downloaded for free from the resources module. More than 200 short modules, each one devoted to a single concept, are also in the Content Module.

TAPING LECTURES

The Zoom lecture sessions will be videotaped, captioned and available for viewing.

LEARNING OBJECTIVES

The learning objectives for this class are algorithmic (computational) and

abstract (theoretical). The computations you are expected to know

are enumerated in the file, **Algorithmic**

Expectations which can be downloaded from the syllabus module.

There are nearly fifty and you need to master them all.

As an example to be successful in this

class, at a minimum, students will demonstrate the ability to

- *Use matrices to solve systems of linear equations. Translate equations*

into matrix form and use Gaussian elimination to find the complete set

of real solutions.

- *Compute the column space and null space of a real matrix as a span of*

a linearly independent sequence of vectors and determine if a given

vector is in the column space or null space of the matrix.

- Determine if a square matrix if invertible and, if so, compute its inverse. Express an invertible matrix as a product of elementary matrices.

- Compute and use properties of the determinant of a square real matrix. Use expansion by cofactors to compute determinants, apply the formula det(AB) = det(A)det(B), and determine invertibility of a matrix by computing the determinant.

- In R^n and other finite dimensional vector spaces determine if a sequence of vectors is linearly independent, is a spanning sequence, or is a basis. Compute the dimension of a subspace of a finite dimensional vector space. Given a basis for a finite dimensional vector space and a vector, compute the coordinate vector with respect to the basis.

- Compute with linear transformations between finite dimensional vector spaces. Determine if a transformation between vector spaces is a linear transformation. Determine if a vector is in the kernel of a linear transformation. Determine if a vector is in the range of a linear transformation. Determine if a linear transformation is injective, surjective, or bijective. Given bases for the domain and codomain of a linear transformation compute the matrix of the transformation.

- Given an n x n real matrix, compute its eigenvalues and determine a basis for the eigenspace associated with each eigenvalue. Determine if a square matrix is diagonalizable.

In the course of mastering these skills, methods, techniques, and algorithms, students will be required to learn many other topics as well, in particular: matrix notation, vectors, row reduction, the span of a sequence of vectors.

In addition, you will also be expected to understand the notions of an abstract vector space, subspace of a vector space, linear span of a set of vectors in a vector space, linear independence and linear dependence of a set of vectors in a vector space, basis of a vector space, dimension of a vector space, as well the concept of a linear transformation from one vector space to another vector space. More precisely, students will be able to:

- *Define, compute, and derive first consequences from the definitions of a vector space, basis, and the dimension of a vector space as applied to subspaces of R^n and other examples: State the definitions of vector space, basis, span, linear independence, and dimension; prove results that follow directly from these definitions; determine if a set of vectors is a basis for a given subspace of R^n or other familiar vector spaces; compute bases and dimensions for vector subspaces of R^n defined by algebraic properties or as spaces associated with matrices; use dimension to compare subspaces and draw conclusions about the linear dependence or independence of a set of vectors*.

GRADING/ASSESSMENT

Grades will be based on the following

Activity	Weight	Points
Participation	6%	60
Pre-class	10%	100
Post-Class	10%	100
Homework	20%	200
Section	10%	100
Midterms (2)	22%	220
Final	22%	220
Total	100%	1000

PARTICIPATION

This is based on attendance via Zoom, completion of a Wellness survey before each class and contribution to a weekly Discussion topic.

PRE-CLASS

There is a pre-class assignment consisting of exercises related to the assigned reading as well as a reflection on the reading. This is due by 1000 am on lecture days.

POST-CLASS

During each lecture you will get access,via Canvas linked to Gradescope, to a quiz on the material discussed in lecture.

You may work in a collaborative group of up to four. Make sure when doing so that the names and ID numbers of every student in the group is entered. These will be due by 1100 pm on the day of lecture.

HOMEWORK

There will be weekly online homework assignment due at 1159 pm on Sunday. This will be accessed and submitted via Canvas.

SECTION

For each section there will be an graded activity to work on collaboratively. The activities will be found and submitted on Canvas. These are due by 1000 PM on Fridays.

MIDTERMS

There will be two midterms. The first assessing knowledge of the material of chapters 1 - 3 of the textbook, the second on the material of chapters 4 and 5. Each will consist of two sections: a multiple choice section on Canvas and a free response/conceptual section submitted on Gradescope, which can be worked on collaboratively in groups of up to four students. The midterms will be released on Canvas at 800 AM on the day scheduled for the exam and be due at 1200 PM (noon) the following day.

FINAL

There will be a comprehensive final. As with the midterms, the final will consist of two sections: a multiple choice section on Canvas and a free response/conceptual section submitted on Gradescope.

EXTRA CREDIT

There will be a few challenge problems for which extra credit can be earned.

POLICY ON LATE SUBMISSIONS

I have a very simple policy to understand: No late submissions are accepted and I will not read or acknowledge requests for exceptions. I know that "stuff happens" - students get ill, have accidents and injure themelves, there are family emergencies, room mate problems, identity problems, relationship problems. You would probably feel obligated to give me a reason for an extension, which means sharing with me what are often very private matters. You should not have to ever be in that situation. So, here is what I do: there will be nine homework assignments, and the lowest score will be dropped. Similarly, there will be nine Section assignments and the lowest

score dropped. There will be about 25 pre-class assignments and the lowest three will be dropped, and 25 post-class assignments and the lowest three will be dropped.

CLASS SCHEDULE

Day of week	**Date**	**Topic**	**Reading**	
Monday	Mar 29	Introduction to linear systems	1.1	
Wednesday	Mar 31	Matrices and echelon forms	1.2	
Friday	Apl 2	Vectors and the Space R^n	2.2	
Monday	Apl 5	Span of a sequence of vectors	2.3	
Wednesday	Aprl 7	Linear independence in R^n	2.4	
Friday	Apl 9	Subspaces and bases in R^n	2.5	
Monday	Apl 12	Dot Product in R^n	2.6	
Wednesday	Apl 14	Introduction to linear transformations	3.1	
Friday	Apl 16	Product of a matrix and a vector	3.2	
Monday	Apl 19	Matrix addition and multiplication	3.3	
Wednesday	Apl 21	Invertible matrices	3.4	
Friday	Apl 23	Elementary matrices	3.5	
Monday	Apl 26	**First Midterm on Chapters 1 - 3**		
Wednesday	Apl 28	Intro to determinants		
Friday	Aprl 30	Introduction to determinants/Properties of determinants	4.1, 4.2	
Monday	May 3	Introduction to abstract vector spaces	5.1	
Wednesday	May 5	Spanning in abstract vector spaces	5.2	
Friday	May 7	Linear independence in an abstract vector space	5.2	
Monday	May 10	Dimension of a Finite Generated Vector Space	5.3	

Wednesday	May 12	Coordiniate vectors and change of basis	5.4	
Friday	May 14	Rank and nullity of a matrix	5.5	
Monday	May 17	Linear transformations between abstract vector spaces	6.1	
Wednesday	May19	Range and Kernel of a linear transformation	6.2	
Friday	May21	Matrix of a linear transformation	6.3	
Monday	May 24	**Second Midterm on Chapters 4 and 5 of etextbook**		
Wednesday	Mar 26	Eigenvalues and eigenvectors of a matrix and linear operator	7.1	
Friday	May 28	Diagonalizable matrices	7.2	
Wednesday	June 2	Orthogonal and orthonormal sequences in R^n	8.1	
Friday	June 4	The Gram-Schmidt Process	8.2	
Wednesday	June 9	Final Exam - Comprehensive		

TIME MANAGEMENT AXIOMS

1. However much time you think it will take, it will always take longer.

2. However much time you think you have, you always have less.

3. Something unexpected will always come up.

4. Its easier to keep up then to catch up.

5. If you are going to fall behind, do it early so you have more time to catch up.

ACADEMIC INTEGRITY

Examinations, homework exercises, homework problems submitted must

be your own work and is not to be shared with other students except as otherwise specified. In general, you may collaborate as a group (and this is encouraged) in discussing strategies and tactics for solving the homework assignments as well as the extra credit problems but submitted work must be entirely in your own words.

Any student discovered to be offering to sell solutions to homework as well as students purchasing solutions will immediately be given a failing grade for the course and referred to their College Provost for disciplinary action.

When I think cheating has occurred on an examination, homework or extra credit submissions I may give the suspected student(s) an oral exam and if they cannot satisfactorily explain the methods and reasoning the entire examination or assignment will be graded zero. A second offense will result in automatic failure in the course.

DISABILITY ACCOMMODATION

If you qualify for classroom accommodations because of a disability, please get an Accommodation
Authorization from the Disability Resource Center (DRC) and submit it to me in person outside of class
(e.g., office hours) within the first two weeks of the quarter. You can contact the DRC at 459-2089 (voice),
459-4806 (TTY), or http://drc.ucsc.edu for more information on the requirements and/or process.