California State University, San Bernardino
College of Natural Sciences / Department of Mathematics
Math 2310, Applied Linear Algebra, Section 2, Fall 2020

Course and Instructor Information

Instructor:	Dr. Jeffrey S. Meyer
Office location:	JB 326
Email:	jeffrey.meyer@csusb.edu
Office hours:	MW 1-2pm & 6-7pm, and by appointment
Office hour link:	https://csusb.zoom.us/j/96666758128?pwd=Rnd1NFNHalB0M2l5cUJtUE50NTlSZz09
Class days/time:	MW 4:00-5:55pm
Class link:	https://csusb.zoom.us/j/97720733928?pwd=THJRYUhucmJzcm5ES2w3NmlwZ0dqdz09

Teaching Methodology

My Philosophy. You learn mathematics by experiencing mathematics, not copying off a board or reading a book. As your instructor, my job is to foster a safe, welcoming environment of exploration, and within that environment, create opportunities for you to experience the material. It is up to you to take advantage of these opportunities, be they during class, office hours, or when you are home.

> *"Never forget that, at the most, the teacher can give you fifteen percent of the art. The rest you have to get for yourself through practice and hard work. I can show you the path but I can not walk it for you."* - Tan Soh Tin, Kung Fu Master

Each day of class will be composed of a mixture of short lectures, group activities, and group discussion. Outside of class, there will be several hours worth of homework, which you are encouraged to work on in groups.

This course is using the style of learning called Inquiry Based Learning (IBL). In this course, I am a coach, a guide, a facilitator, and meanwhile it is you who drives the progress of the course. While hard work, IBL courses have been shown in scientific studies to generally provide more significant, positive educational experiences for students as compared to a standard course.

Ways of Understanding. To the extent to which it is possible, you will be challenged to (and expected to) understand every concept verbally, visually, numerically, and symbolically.

Don't ever forget, I want to see each and every one of you succeed.

Course Description

Introduction to the algebra and geometry of vectors and matrices over the real numbers with an emphasis on conceptual understanding and applications. Topics will include solving systems of linear equations, linear transformations, eigenvalues and eigenvectors, vector products, orthogonal projections, and vector parametrizations of curves in two and three dimensions. Applications of these topics may include computer graphics, electrical networks, difference equations, dynamical systems, and economics. Students should expect to make appropriate use of technology for visualization and computation.

Prerequisites

Semester Prerequisite: MATH 2210 with a grade of C- or better; and MATH 2220 as a pre- or co-requisite. Quarter Prerequisite: MATH 212 with a grade of C- or better

Course Goals/Objectives and Student Learning Objectives/Outcomes

As a course in the math department, we have the following Program Student Learning Outcomes (PLOs). Upon successful completion of this course, students will:

1.1. Demonstrate an understanding of fundamental concepts, algorithms, operations, and relations.

2.1. Correctly apply mathematical theorems, properties and definitions.

3.1. Students will justify solutions using a variety of strategies and representations.

What to do when you have a question?

1. Talk to classmates / Study groups

2. Math Gym
   https://www.csusb.edu/mathematics/undergraduate/math-gym-tutoring

3. Office Hours / Email Me

Textbook References

Each of the following three texts offer something different. I *highly encourage* you to obtain a copy of each to read and reference. However, we will usually follow my class notes and I will not usually assign specific readings from them

1. Concepts of Linear Algebra by Jeffrey S. Meyer (Me)

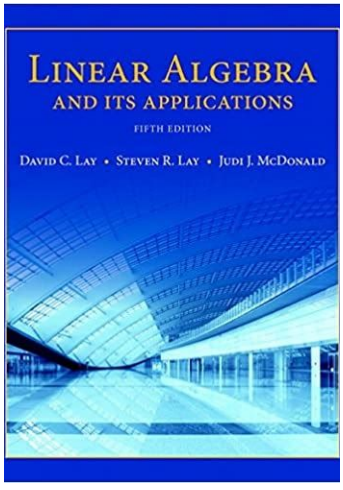
   This text will be provided to you free of charge. Please, please do not post or share this text or associated homework with others. This includes posting any component on websites such as Chegg. This is the most important reference of the course. We will closely follow my text during class days, and homework and exams will be very similar in nature to my text.

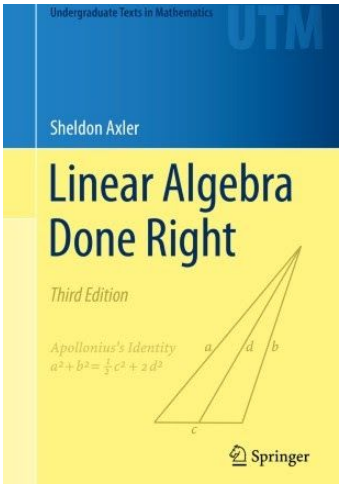
2. Linear Algebra and its Applications by Lay, Lay, and McDonald
   ISBN-13: 978-0321982384
   ISBN-10: 9780321982384

   This is a standard traditional text with many examples and practice problems to work through. It will be **your responsibility** to use this text as a resource for working through examples and doing practice problems.

3. Linear Algebra Done Right by Sheldon Axler
   ISBN-13: 978-3319307657
   ISBN-10: 3319307657

   A rigorous, algebraic approach to linear algebra.





Technology

Gradescope.

To submit your homework each week. (To turn images into pdfs: Genius Scan, Adobe Scan)

GeoGebra.

To visualize, compute, and experiment. www.geogebra.com

Zoom.

For class and office hours.

Overleaf. (or equivalent) (Optional)

To write up homework in LaTeX.

Slack.

To stay connected, ask and answer questions through the course.

https://www.csusb.edu/mathematics/undergraduate/guide-using-digital-resources-your-math-courses

Expectations At Home

Per the University Catalog, students are expected to complete a minimum 2 hours of homework for every hour of classwork. As this is a 4 credit hour course, I expect you to work a minimum of 8 hours per week outside of class. Students who are unable to assume this responsibility because of other time conflicts put themselves at risk for a failing grade in the course.

Expectations in Class

I expect you will pay attention during the brief lectures and you will be active and on task during group work and discussion. (At no point is it acceptable to be emailing, texting, or otherwise playing with your electronic devices.)

Zoom Etiquette

Share Video or Profile Picture.

Set your name to be the your First Name (or whatever (appropriate) name you wish to be called) + Last name or initial

Main room etiquette. Mute.

Breakout rooms etiquette. Unmute and introduce yourself.

Grades

There are 1000 points: Participation (150), WeBWorK (200), Homework (200), and Exams (400). You will earn at least the following grade given the associated number of points:
A- (900 points), B- (800 points), C- (700 points), D- (600 points).

Participation (150 points).

Points are based on attendance and participation, and each week you may earn 10 points for submitting group work activities. Attendance is taken each day. For each unexcused absence after your third, 20 points will be deducted from your participation score.

WeBWorK. (200 points)

Each week you will be assigned WebWork. These exercises are more *computational* in nature. Each WebWork assignment is worth 20 points. You will have multiple tries for each exercise and will get instantaneous feedback. They are all open now and close Mondays at 11:59pm PT. You can access WebWork by selecting our section and signing in at webwork.csusb.edu. Your two lowest WebWork scores will be dropped at the end of the term.

Homework. (200 points)

Each Wednesday, you will be assigned problems to be clearly written up and submitted on Gradescope (gradescope.com) the following Thursday night at 11:59pm. These are *conceptual* in nature. They will be graded and returned the following week. Each written assignment is worth 25 points. You are encouraged to work in groups, but you must turn in your own work. Your lowest homework score will be dropped at the end of the term.

On each written assignment, 4 problems (5 points each) will be chosen to be graded for correctness and clarity of presentation, while remaining problems will be graded for completion (5 points), but the grader reserves the right to deduct up to 5 points for being illegible, poorly written, messy, or just otherwise low quality (spiral notebook fringe and no staple are automatic deductions).

Exams. (450 points, 150 points each)

There will be two midterm and one final assessment in the course, evenly distributed through the term (roughly weeks 6, 11, and 16). These exams are cumulative.

Intellectual Honesty

Using the internet or looking in the back of the book to find solutions can easily lead to, perhaps unintentional, cases of plagiarism. It may seem that you are learning how to do assigned homework when you use the internet and/or book solutions; however, this practice is very strongly discouraged since this approach often gives a false illusion of learning. How will I know if you are struggling with a problem if the work presented originated from someone else? Furthermore, this kind of "learning" does not translate well to exams or being able to apply the content in future classes.

Have faith in yourself. Some homework problems are intended to be challenging. Know that the problems are chosen with your skillset in mind. True learning occurs when you engage in a productive struggle with a problem and discover how to make use of the problem-solving tools you have developed during your studies. The only way to learn concepts deeply is to work thoughtfully and engage your brain. Did you know that when we learn a new idea, an electric current fires in our brains, crossing synapses and connecting different areas of the brain? (From Jo Boaler – Mathematical Mindsets) You are growing your brain when you struggle with new ideas.

If you choose to use content from an outside resource, it is imperative to give credit in order to avoid a plagiarism offense. If you used the source extensively, the work may not earn full credit, but this is better than the alternative penalty that plagiarism would warrant. Note that outside resources include the internet, tutors, and peers.

When acknowledging the use of a source, you should both cite the source and indicate to what extent you used it. Here are some sample sentences:

- My (classmate/parent/sibling/friend, include name) showed me how to do this problem and my argument is very similar to theirs. I did try to write it in my own words. I think I mostly understand the problem, but I may need more review.
- I looked up the solution to this problem here: (give link or reference). Although I got an idea of how to do the problem from this source, I adapted the method and rewrote in my own words. I feel I have a very strong understanding of the structure of this problem.
- I looked up this result at the following website: (copy link here). This solution is essentially the same as the one on the site because I couldn't figure out a way to rewrite it differently. My understanding of this problem isn't quite solid yet.

University Policies

Plagiarism and Cheating

Students are expected to be familiar with the University's Policy on cheating and plagiarism. Please review this in the "Academic Regulations" section of the CSUSB Bulletin. Plagiarism and cheating are violations of the Standards for Student Conduct (Title 5, §41301, California Code of Regulations). Definitions and procedures for addressing cheating and plagiarism are found in the Faculty Senate's Policies and Procedures Concerning Academic Dishonesty (FAM 803.5) and Executive Order 1098-Revised 3/29/2019 - Student Conduct Procedures, and may be addressed by both the instructor and the Student Conduct Administrator.

Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified.

Dropping and Adding

You are responsible for understanding the policies and procedures about add/drops, academic renewal, etc. found in the CSUSB Bulletin.

Support for Students with Disabilities

If you are in need of an accommodation for a disability in order to participate in this class, it is your responsibility to seek academic accommodations for a verified disability in a timely manner. Please contact the instructor during the first week of the term and contact Services to Students with Disabilities (SSD) at (909) 537-5238. SSD must provide documentation to the instructor in order for special accommodations to be made.

If you require assistance in the event of an emergency, you are advised to establish a buddy system with a buddy and an alternate buddy in the class. Individuals with disabilities should prepare for an emergency ahead of time by instructing a classmate and the instructor.

Course Schedule

(Note: subject to change with fair notice.) Here is the anticipated agenda for the semester.

Week	Section #	Topic
1	2.1	Vectors as Arrows and Lists
1	2.2	Vector Operations and LInear Combinations
2	2.3	Lines and Planes
2	2.4	Span an Dependence - Fist Pass
2	3.1	Matrix Multiplication as Linear Combination
3	3.2	Matrix Multiplication as Linear Transformation
3	3.3	Matrix Equations as Intersecting Hyperplanes
3	4.1	Developing Intuition for Solution Sets
4	4.2	Symbolically Finding Solution Sets 1: Elimination
4	4.3	Elimination as Matrix Multiplication: Elementary Matrices
5	5.1	Concepts of Dependency
5	5.2	Concepts of Spanning
5	5.3	Basis as Coordinate System
		Midterm Assessment
6	6.1	Concepts of Reversing a Process
6	6.2	Strategies for Computing an Inverse
6	6.3	Symbolically Finding Solution Sets 2: Inverses
7	7.1	The Idea of Matrix Decompositions
7	7.2	Similar Matrix Decomposition
7	7.3	Elementary Matrix Decomposition
8	7.4	LU-Decomposition
8	7.5	Symbolically Finding Solution Sets 3: LU-Decomposition
8	8.1	Area Scaling Factor and the Sign
9	8.2	Concepts of the Determinant
9	8.3	Strategies for Computing the Determinant
9	9.1	Concepts of Invariant Lines
10	9.2	Algebraically Finding Invariant Lines
10	9.3	Dynamically Finding Invariant Lines

10	9.4	Classification of Eigenstuff in the Plane
		Midterm Assessment
11	10.1	Concepts of Length, Angle, and Projection
11	10.2	Concepts of Orthogonal Vectors
12	10.3	Strategies for Finding Orthonormal Bases (Gram-Schmidt Algorithm)
12	10.4	QR-Decomposition
13	10.5	Concepts of Subspace Projection
13	10.6	Approximating Solutions Sets: Linear Least Squares (LLS)
14	11.1	Concepts of Self-Adjoint Transformations
14	11.2	The Real Spectral Theorem
15	11.3	Polar Decomposition
15	11.4	Singular Value Decomposition
15	11.5	PCA
		Final Assessment