Math 150
Linear Algebra
Fall 2020

Section 01
MTWF
2:00 - 2:50 am
CAE 208

Instructor

Dr. Lauren Williams

Old Main 404

lwilliams@mercyhurst.edu

(814) 824-2226

Important Dates

Aug 19	First Class
Aug 31	Add-Drop Deadline
Sep 20	Exam I
Oct 14	Advising Day
Oct 20	Exam II
Nov 24	Exam III
Nov 24	Last Class

Office Hours

Monday 10:00 - 11:00

Tuesday 3:00 - 4:00

Wednesday 12:00 - 12:45

Thursday 9:00 - 9:30

Thursday 2:00 - 3:30

and by appointment

Course Description

This is a one semester course in linear algebra with computer applications. We will be covering the following topics: matrices and matrix properties, vectors and vector spaces, linear systems, and linear transformations. The class lectures will focus primarily on definitions and theory, with some simple calculations being performed without the aid of a computer. We will also have time dedicated to applying the ideas learned in class to actual problems.

Topics will include vectors and vector arithmetic, solutions of linear systems, Gaussian elimination, inner products, vector spaces and subspaces, the four fundamental subspaces, determinants, eigenvalues and eigenvectors, symmetry, linear transformations, and applications.

Course Objectives

On successful completion of the course, students should be able to:

- describe the solution(s) of a system of linear equations, or decide that one does not exist.

- perform arithmetic operations on vectors and matrices, where defined.

- calculate the determinant of a matrix, and understand its significance.

- define a vector space and determine whether or not a set is a vector space.

- find the basis and dimension of a vector space.

- define and identify linear transformations and their properties.

- define and compute eigenvalues and eigenvectors.

- explain the geometric effect of a linear transformation on 2-dimensional and 3-dimensional spaces.

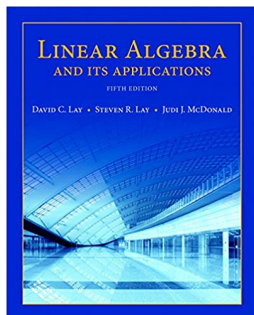**Dr. Williams' Website:** https://www.integral-domain.org/lwilliams/

Prerequisites

Math 170 or equivalent, or instructor permission.

Office Hours

For the Fall 2020 semester, I will be unable to meet with students in my office. Office hours will be conducted via Zoom. As always, your presence at office hours is welcome but optional.

Required Materials

Textbook

Linear Algebra and its Applications, by David Lay, Steven Lay, and Judi McDonald, 5th Edition. If you have a different edition of the textbook, it is up to you to make sure the sections and assigned problems are the same.

You will not be expected to bring your textbook to class. If you prefer to purchase or rent an electronic version of the text, you are welcome to do so.

Online Resources

We'll be making use of two learning platforms this semester: Blackboard and Moodle. On Blackboard, you'll find notes and videos for all sections of the course, as well as important course announcements and your current grades.

Labs

While understanding the theory and mechanics of linear algebra is critical to truly applying it, the majority of the calculations we'll do "by hand" in class are actually done by a machine in the real world.

To help balance these two sides of linear algebra, we'll use most of our Tuesday class meeting time to explore applications and see how a computer algebra system (CAS) can make our work easier and faster.

In particular, we'll be experimenting with SAGE, an incredibly powerful and open source (free) CAS based on the Python programming language.

You will not have any required lab assignments for this course. Instead, consider the lab meetings as a kind of "show and tell" for linear algebra. We'll see how to make predictions with biological important, how linear algebra can be used to solve some games and puzzles, and how data science (a fast growing and important field) relies on linear algebra. And, if there's a certain application you're interested in, please let me know so I can make sure it is mentioned.

You will not need any supplies for these lab meetings. If you have a laptop, you are welcome to bring it and follow along or experiment on your own.

Moodle

Moodle is a Learning Management System, similar to Blackboard, that allows for flexible mathematics based quizzes. We will be using Moodle for all quizzes and labs. There is no fee for using Moodle.

Accessing Moodle

At the beginning of the semester, you will receive an email (delivered to your Mercyhurst email address) with information on enrolling in the Moodle course. You will be required to create a password. Be sure to keep this password safe, and do not share your login information with other students in the course.

There is a mobile app available for Moodle, but it is not recommended for use in this course. A computer (desktop or laptop) or tablet is strongly preferred, using the Moodle website as opposed to the app.

If you already have a Moodle account and would like to use it rather than the new one generated for you, just let me know. You can link the course to any existing account.

Question Styles

The quizzes and exams you'll take on Moodle are based on homework problems from the textbook. Some questions are multiple choice, and others will require you to enter a numerical answer. When necessary, specific instructions will be provided with a question. Questions will be asked one at a time, so you can focus on each individual question as you work.

Time Restrictions

You will be required to finish each quiz within 90 minutes. Any work you have completed will be submitted at the end of this period, even if you have not finished the assessment.

Availability Windows

Each quiz and can only be submitted during its availability window. You will have a 24 hour period, from 12 am until 12 pm, in which to complete the quiz on the dates in this syllabus.

Please note that once you begin a quiz, you will be required to complete it within the given time period or before the end of the availability window, whichever comes first. For instance, if you begin a quiz at 11 pm, you will only have 1 hour to finish. Be sure to allow yourself enough time to finish each assessment before you begin.

Grades

Your quiz grades will be available immediately. Correct answers and detailed solutions will be available the day after the quiz is available. Grades will be transferred to Blackboard so you can keep track of your overall progress in the class.

Technical Support

The Moodle website has a support page with answers to many common questions:
https://support.moodle.com/hc/en-us.
If you have questions or issues with the course itself, or if you encounter any problems with a quiz, please notify me as soon as possible.

HOMEWORK

Suggested problems from the textbook for each section we will cover are included in this syllabus. Your work will not be collected. However, actually working through these problems is the key to your success in this class. Attending every class is not enough; mathematics can only be learned through practice. It is expected that you spend approximately 8-12 hours per week studying the material outside our class meetings, according to the typical 2-3 hours per credit rule.

Most of the problems will have solutions in the back of the textbook. Make sure to check your work. The exams will be based primarily on these problems. While you are encouraged to work together on the homework, be sure you understand all material on your own before a quiz or exam.

Sec.	Problems
1.1	1, 3, 7, 9, 11, 13, 15, 17, 19, 21, 23, 24, 26
1.2	1, 5, 7, 9, 11, 13, 15, 19
1.3	1, 5, 9, 11, 13, 15, 19, 23
1.4	1, 5, 7, 9, 11, 13, 15, 21, 25, 37
1.5	1, 3, 5, 7, 9, 11, 33, 35
1.7	1, 3, 5, 7, 9, 11, 15-20, 21, 29, 31
1.8	1, 3, 5, 9, 11, 13, 15, 17
1.9	1, 3, 9, 15, 17, 19, 21, 37
2.1	1, 3, 5, 7, 9, 11, 12, 15, 23, 27
2.2	1, 3, 5, 7, 9, 17, 18, 29, 31, 33
2.3	1, 3, 5, 7, 9, 13, 15, 23, 33
2.5	3, 5, 9, 11, 19
3.1	1, 3, 5, 9, 11, 13, 19, 21, 23, 37, 41
3.2	15, 17, 19, 21, 23, 25, 27, 29, 33, 35, 37, 39
3.3	1, 3, 5, 7, 19, 21, 23, 27
4.1	1, 3, 5, 6, 7, 8, 9, 10, 11, 13, 15, 16, 17, 18, 21
4.2	1, 3, 5, 7, 9, 11, 23
4.3	1, 3, 5, 7, 9, 15, 19, 21
4.5	1, 3, 5, 7, 9, 11, 13, 15, 17, 25
4.7	1, 7, 9
5.1	1, 3, 5, 7, 9, 11, 13, 17, 19, 21, 24
5.2	1, 3, 5, 7, 9, 13, 15, 21
5.3	1, 5, 7, 9, 11, 21, 27
5.5	1, 3, 5
6.1	1, 3, 5, 7, 9, 11, 15, 17, 19, 23, 25, 27
6.2	1, 5, 9, 11, 13
6.4	1, 5, 11, 15

FINAL GRADE COMPONENTS

Quizzes

Keeping up with the homework will ensure that you are prepared for the quizzes, which will feature problems very similar to those in the homework as well as more conceptual questions about the topics you'll see each week.

There is a total of 11 quizzes scheduled for the semester. Your lowest quiz grade will be dropped, including a missed quiz. Each quiz will be available for a 24 hour period (midnight to midnight) on Moodle as shown in the course schedule. You'll know your quiz grade as soon as you're finished with it, but the correct answers will not be visible until the quiz has closed.

Before you can get started with a graded quiz, you'll need to complete a Quiz Tutorial on Moodle. This ungraded quiz (that will not test your mathematical knowledge) will help you get acquainted with the quiz layout and how to enter your responses.

You will have 90 minutes to complete each quiz from the time you begin, so please be sure that you allow time to finish a quiz before starting. You can sign off and return to Moodle after starting a quiz, but your time will end after 90 minutes from when you first accessed the quiz. You will only have one chance to take each quiz, and will not be able to change your responses after submitting. You will not be required to submit any written work for your quizzes.

Exams

There will be three midterm exams given throughout the semester, according to the semester schedule. The material on the exams will be similar to topics covered on quizzes and homework. All exams should be considered cumulative; each exam will include some material from the previous exams.

GRADING

Your final grade will be calculated as follows:

Component	Value	Total Points
Quizzes (10 best)	20 points each	**200 points**
Exams (3)	100 points each	**300 points**
		500 points

Your letter grade will be based on the total number of points you earn throughout the semester:

Grade	Percentage	Points Needed
A	90	**448**
B+	87	**433**
B	80	**398**
C+	77	**383**
C	70	**348**
D+	67	**333**
D	60	**298**

Other Course Information

- If you are struggling with a topic, please come to office hours as soon as possible. Tutoring for this course can not be expected through our usual department tutors, but it may be possible to arrange private assistance. Don't let yourself fall behind!

- There are other linear algebra textbooks available in the library and in my office. Due to book prices, you may not want to invest in a second book, but it can be helpful to have alternate sources or see topics explained in other ways. Two free texts available online:

    - Linear Algebra, by Jim Hefferon, Saint Michael's College
      http://joshua.smcvt.edu/linearalgebra/
    - A First Course in Linear Algebra, by Robert Beezer, University of Puget Sound
      http://linear.ups.edu/

- You are free to use any electronics (phone, tablet, laptop, etc) in class, but please use devices in a way that does not distract other students in the class.

ADA and Learning Differences

Mercyhurst University is committed to making reasonable accommodations for qualified students, and employees with disabilities as required by law. Individuals seeking an accommodation for a disability must submit a written request outlining the specific accommodation request being made. Supporting documentation may also be required. To request an accommodation, contact Alice Agnew, Director of Equal Opportunity Programs, 311 Egan Hall, aagnew@mercyhurst.edu, 814-824-2362.

Title IX Information

Mercyhurst is committed to providing an environment free from sex discrimination, including sexual harassment and sexual violence. Please refer to the Title IX – Sexual Respect button on the HUB for more information. If you would like to file a sexual misconduct complaint, please contact Mercyhurst Title IX Coordinator Alice Agnew, 311 Egan Hall, aagnew@mercyhurst.edu, 814-824-2362. Please be aware that in compliance with Title IX educators must report incidents of sexual assault/harassment, stalking, and domestic/dating violence. If you disclose any of these situations in class, in papers, or to me personally, I am required to report it to the Title IX Coordinator (or any of the Deputy Title IX Coordinators).

Academic Honesty

Students are required to uphold academic integrity throughout the course. In particular, plagiarism of any sort, unauthorized collaboration on exams, quizzes and other assignments, and other incidences of academic dishonesty will be handled according to the policies set forth in the Student Handbook.

Course Evaluations

Near the end of the semester, you will be asked to complete an online course evaluation. The evaluation will be completed in class during the last two weeks of the semester using any laptop, tablet, or mobile device. The response tool allows you to note aspects of the course that helped you learn, as well as aspects that might be modified to help future students learn more effectively. You will receive an email letting you know when the evaluation window for our class is open. Please note that these course evaluations are anonymous and instructors do not see the results until after the grades for the course are submitted.

SEMESTER SCHEDULE

IMPORTANT NOTE FOR FALL 2020:
Due to the current COVID-19 pandemic, it is more likely than usual that our semester plans will be altered. While I will attempt to follow this schedule as closely as possible, please make a note of any announced changes to important dates in class or on Blackboard.

Monday	Tuesday	Wednesday	Friday
		Aug 19 Class Intro	**Aug 21** 1.1 Systems of Linear Equations
Aug 24 1.1 Systems of Linear Equations	**Aug 25** Lab: Intro to SAGE	**Aug 26** 1.2 Row Reduction and Echelon Forms	**Aug 28** **Quiz** 1.2 Row Reduction and Echelon Forms
Aug 31 *Add/Drop Deadline* 1.3 Vector Equations	**Sep 1** Lab: Interpolation	**Sep 2** 1.4 The Matrix Equation $Ax = b$	**Sep 4** **Quiz** 1.4 The Matrix Equation $Ax = b$
Sep 7 1.5 Solution Sets of Linear Equations	**Sep 8** Lab: Leontief Models	**Sep 9** 1.7 Linear Independence	**Sep 11** **Quiz** 1.8 Introduction to Linear Transformations
Sep 14 1.8 Introduction to Linear Transformations	**Sep 15** Lab: Leslie Models	**Sep 16** 1.9 The Matrix of a Linear Transformation	**Sep 18** **Quiz** 2.1 Matrix Operations
Sep 21 2.1 Matrix Operations	**Sep 22** Exam I	**Sep 23** 2.2 The Inverse of a Matrix	**Sep 25** 2.2 The Inverse of a Matrix
Sep 28 2.3 Characterizations of Invertible Matrices	**Sep 29** Lab: Color Transformation	**Sep 30** 2.5 Matrix Factorization	**Oct 2** **Quiz** 2.5 Matrix Factorization
Oct 5 3.1 Introduction to Determinants	**Oct 6** Lab: Hill Ciphers	**Oct 7** 3.1 Introduction to Determinants	**Oct 9** **Quiz** 3.2 Properties of Determinants
Oct 12 3.3 Cramer's Rule	**Oct 13** Lab: Check Digits	**Oct 14** 3.3 Cramer's Rule	**Oct 16** **Quiz** 4.1 Vector Spaces and Subspaces
Oct 19 4.1 Vector Spaces and Subspaces	**Oct 20** Exam II	**Oct 21** 4.2 Null Spaces, Column Spaces	**Oct 23** 4.3 Linearly Independent Sets and Bases
Oct 26 4.3 Linearly Independent Sets and Bases	**Oct 27** Lab: Coordinate Systems	**Oct 28** 4.5 The Dimension of a Vector Space, 4.6 Rank	**Oct 30** **Quiz** 4.7 Change of Basis
Nov 2 5.1 Eigenvectors and Eigenvalues	**Nov 3** *Advising Day* Lab: Markov Chains	**Nov 4** 5.1 Eigenvectors and Eigenvalues	**Nov 6** **Quiz** 5.2 The Characteristic Equation
Nov 9 5.3 Diagonalization	**Nov 10** *Last day to withdraw* Lab: Page Rank	**Nov 11** 5.3 Diagonalization	**Nov 13** **Quiz** 5.4 Eigenvalues and Linear Transformations/5.5 Complex Eigenvalues
Nov 16 6.1 Inner Product, Length, Orthogonality	**Nov 17** Lab: Data Clustering	**Nov 18** 6.1 Inner Product, Length, Orthogonality	**Nov 20** **Quiz** 6.2 Orthogonal Sets
Nov 23 6.4 Gram-Schmidt	**Nov 24** Exam III	*Nov 25* *Thanksgiving Break*	*Nov 27* *Thanksgiving Break*

COVID-19 Information

This is sure to be an unprecedented semester! While we cannot know what the next few months will bring, we must all work together to keep our campus community safe and healthy.

This page features information regarding policies of the University (in italics) as well as comments, suggestions, and requests that pertain to our class specifically.

Face Masks

As per the COVID-19 Prevention, Mitigation, and Response Policy, Mercyhurst University is requiring that all members of the campus community wear a cloth or disposable face covering over their nose and mouth when on campus. Please refer to the policy for specific details as to where and when face coverings are required. Students may use their own face coverings or those provided by the University. A student in need of a face covering should email covid19@mercyhurst.edu or call 814-824-3600 to find the nearest location where face coverings are available. The University's Mask/Face Coverings Policy will be enforced in this class.

I will have a few disposable masks with me in case you need to borrow one, but please understand that these supplies are limited.

Sanitation and Safety

In keeping with the COVID-19 Prevention, Mitigation, and Response Policy, students are expected to use hand sanitizer and to wipe down their desks using disinfectant wipes when they enter and exit the classroom. Classrooms have been provided with sanitizer and disinfectant wipes for student and faculty use.

Eating and Drinking in the Classroom

In light of the COVID-19 situation, Eating is not permitted in classrooms, labs, or other academic spaces. A water bottle or cup with a lid, and straw preferably, is permitted to be used in classrooms and labs to help prevent a student from becoming uncomfortably parched. Masks should be pulled only slightly away from the bottom of the face to take a quick drink and immediately replaced to covering the mouth and nose.

Class Dismissal, Congestion Prevention

In keeping with the COVID-19 Prevention, Mitigation, and Response Policy, faculty members and students should take steps to avoid crowding outside of classrooms, in hallways, and any enclosed area in university buildings. All rooms will be designated with signs indicating maximum capacity for specific instructional use. These must always be adhered to. Students waiting to enter classrooms or exiting classrooms should always maintain a minimum of 6 feet of distance from others. Class time endings may be adjusted when necessary to minimize overcrowding or congestion.

Seating Chart

In compliance with federal and state regulations, the University must be able to conduct contact tracing if there is a positive test or an outbreak; therefore, seating charts are mandatory for all in-person classes. Students will be required to sit in the same seat in the classroom each time they attend class. The seating chart will be available for review for purposes of contact tracing.

Paper Sharing Policy

We will not be exchanging paper this semester. Supplemental materials will be distributed and made available electronically. Assignments and exams will be submitted electronically as well. You are welcome to bring your own paper to class to take notes, but you may not pass paper to a classmate or to me.

Attendance, Missed Class

Attendance at all classes is expected. However, it is important that students and course instructors adhere to the university's COVID-19 mitigation policies and strategies. As such, a student who misses class due to illness or suspected illness within the context of those policies will not be penalized and will be provided sufficient means to make up any missed course content or work and remain actively engaged in the class.

The word "attendance" has a broader definition than usual this semester. While attending class is certainly preferred, please do not feel obligated to come if have any potential symptoms. I plan to record all class meetings via Zoom, and those recordings will be available on Blackboard throughout the semester. You can also join and participate in the live Zoom meeting. If you're not up to joining in, watch the meeting and the associated pre-recorded video lectures when you're able to.

If you are unable to attend class (or join the live Zoom meeting) for more than a few days, please let me know as soon as possible. I am happy to work with you in building a plan that allows you the time off you need without risking your academic progress.

Potential Class Changes

Mathematics students are a rare breed, which this semester is a good thing: it means that our class is small enough to safely meet in person! It is my hope that we remain able to meet in person as scheduled for the entire semester. However, there is a very good chance that our plans will change, and without much notice.

Our highest priority (even above learning about determinants and vector spaces) is to remain healthy and safe. We will all need to remain responsible, flexible, and understanding to make this semester a success, and I have full confidence that we will be able to achieve that goal.