LINEAR ALGEBRA

MEETING INFORMATION

Meeting Times	MWThF 11:00 - 11:50
Location	MWF: Hirt 209
	Th: Main Lab
Website	math.mercyhurst.edu/∼lwilliams/math150
Prerequisite(s)	Math 170

Instructor	Lauren Williams, PhD
Email	lwilliams@mercyhurst.edu
Office Phone	(814) 824-2226
Office	Old Main 404

Office Hours	Mon	1:00 - 1:50
	Tues	9:30 - 11:00, 3:30 - 4:00
	Wed	1:00 - 1:50
	Thurs	9:00 - 10:00
	Fri	1:00 - 1:50

GRADING

40%	**Midterm Exam Average**
20%	**Final Exam**
20%	**Quiz Average (1 lowest dropped)**
20%	**Labs (1 lowest dropped)**

A	B+	B	C+	C	D+	D
90	87	80	77	70	67	60

IMPORTANT DATES

Aug	**23**	First Class Meeting
	28	Last Day to Add/Drop
Sep	**4**	Labor Day, No Class
	21	Mass of the Holy Spirit, No Lab
	28	Midterm I
Oct 12-13		Mid-Semester Break, No Class
	31	Advising Day
Nov	**2**	Midterm II
	17	Last Day to Withdraw
	22-24	Thanksgiving Break, No Class
Dec	**8**	Last Class Meeting
	15	Final Exam 10:30 - 12:30

REQUIRED MATERIALS

Linear Algebra and its Applications, by David Lay, Steven Lay, and Judi McDonald, 5th Edition.

COURSE CALENDAR

Aug	**23**	Class Intro, Overview	
	24	*Lab 1 Intro to Sage*	
	25	Systems of Linear Equations	
	28	Systems of Linear Equations	
	30	Row Reduction and Echelon Form	
	31	*Lab 2 Interpolation*	
Sep	**1**	Row Reduction and Echelon Form	Quiz
	4	*Labor Day - No Class*	
	6	Vector Equations	
	7	*Lab 3 Linear Models in Science*	
	8	The Matrix Equation $Ax = b$	
	11	The Matrix Equation $Ax = b$	
	13	Solution Sets of Linear Systems	
	14	*Lab 4 Lights Out*	
	15	Solution Sets of Linear Systems	Quiz
	18	Linear Independence	
	20	Linear Independence	
	21	*Mass of the Holy Spirit - No Lab*	
	22	Matrix Operations	
	25	Matrix Operations	
	27	Review	
	28	Midterm Exam I	
	29	Inverse of a Matrix	
Oct	**2**	Inverse of a Matrix	
	4	Characterizations of Invertible Matrices	
	5	*Lab 5 Hill Ciphers*	
	6	Partitioned Matrices	Quiz
	9	Intro to Determinants	
	11	Properties of Determinants	
	12-13	*Mid Semester Break - No Class*	
	16	Cramer's Rule, Volume, Transformations	
	18	Vector Spaces and Subspaces	Quiz
	19	*Lab 6 Computer Graphics*	
	20	Vector Spaces and Subspaces	
	23	Null Spaces, Column Spaces	
	25	Linearly Independent Sets, Bases	Quiz
	26	*Lab 7 Coordinate Systems*	
	27	Linearly Independent Sets, Bases	
	30	Dimension of a Vector Space	
Nov	**1**	Review	
	2	Midterm Exam II	
	3	Change of Basis	
	6	Eigenvectors and Eigenvalues	
	8	Eigenvectors and Eigenvalues	
	9	*Lab 8 Linear Models in Economics*	
	10	The Characteristic Equation	Quiz
	13	The Characteristic Equation	
	15	Diagonalization	
	16	*Lab 9 Singular Value Decomposition I*	
	17	Inner Products, Length, Orthogonality	
	20	Inner Products, Length, Orthogonality	
	22-24	*Thanksgiving - No Class*	
	27	Orthogonal Sets	
	29	Intro to Linear Transformations	
	30	*Lab 10 Singular Value Decomposition II*	
Dec	**1**	Intro to Linear Transformations	Quiz
	4	Matrix of a Linear Transformation	
	6	Matrix of a Linear Transformation	
	7	*Lab 11 Data Driven Recommendations*	
	8	Review, Last Class Meeting	
	15	Final Exam 10:30-12:30	

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. After learning the basic principles and theory of each topic, we will reinforce the material using the open source mathematics software SAGE. Through a series of lab experiments, you will also gain familiarity with the programming language Python. Many of these lab experiments will focus on applications of linear algebra to other areas of mathematics and other fields, including data science.

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.
- produce and utilize simple Sage programs to perform computations related to all of the above topics.

Quizzes

You will be given quizzes on the material regularly. Keeping up with the suggested textbook homework will ensure that you are prepared for the quizzes, which will feature problems very similar to those in the homework. The dates for quizzes is provided in the course schedule; note that exact topics covered on a quiz is subject to change. Any changes will be announced in class.

Make up quizzes will only be given for excused absences. **All make ups must be completed before the graded quizzes are returned to the class; this will typically be the next class meeting.** Your lowest quiz grade will be dropped when calculating your final grade, including a missed quiz.

Quiz grades will not be based strictly on whether or not you found the correct answer. Your work must also be written clearly, and with proper notation, to receive full credit.

Exams

We will have two midterm exams. Use of notes, textbooks, calculators, electronic devices, or other materials will not be permitted during an exam. If you will not be able to attend class for an exam, please let me know before the exam is scheduled. Make up exams may be arranged for excused absences only.

Midterm 1: Thursday, September 28
Midterm 2: Thursday, November 2

The final exam will be cumulative, and is scheduled for Friday, December 15, 10:30 - 12:30.

Labs

On most Thursdays, we will meet in the computer lab to explore applications of linear algebra, using the computer to solve problems that would be unreasonable to approach by hand. While some programming will be involved, you are not expected to have any experience in programming.

Any software we use in class will be open source or at least free, so you will not need to invest in any materials besides the course textbook. However, if you would like to use the software outside of class, you will be able to install or access it on your home computer as well.

You will not need to have a computer in class or at home in order to complete lab assignments. Most assignments will be completed by the end of the lab period. Your lowest lab grade will be dropped from your final grade, including a missed lab.

Textbook Problems

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.

Stay up to date with homework, and get help if you cannot understand a problem after trying it on your own. Do not ignore a problem that you are struggling with. If you are having trouble with a topic, please come talk to me during office hours, ask questions in class, or seek help from a classmate. You are expected to try to work on all problems on your own first; when coming to my office, be prepared to show me what you've already tried.

1.1	1, 3, 5, 7, 9, 11, 13, 17, 19, 26
1.2	1, 3, 5, 7, 11, 17, 19, 29
1.3	1, 3, 5, 9, 11, 13, 15, 19, 21
1.4	1, 2, 3, 4, 5, 9, 11, 13, 15, 25, 29
1.5	1, 3, 5, 7, 11, 29, 31, 35
1.7	1, 3, 5, 7, 9, 15, 17, 19, 21, 25, 29
2.1	1, 2, 3, 7, 9, 10, 11, 15, 17, 27
2.2	1, 2, 3, 4, 7, 18, 29, 31, 32
2.3	1, 3, 5, 11, 13, 15
2.4	1, 3, 5, 7, 13
3.1	1, 3, 5, 9, 11 21, 23, 37, 41
3.2	15, 17, 19, 21, 25, 29, 33, 35, 37, 39
3.3	1, 3, 5, 7, 19, 21, 23

4.1	1, 3, 5, 6, 7, 8, 9, 10, 11, 13, 21
4.2	1, 3, 5, 7, 9, 11
4.3	1, 3, 5, 7, 9, 15
4.5	1, 3, 5, 7, 9, 11, 13, 25
4.7	7, 9
5.1	1, 3, 5, 7, 9, 11, 13, 17, 19
5.2	1, 3, 5, 7, 9, 13, 15
5.3	1, 7, 9, 11
6.1	1, 3, 5, 7, 9, 11, 15, 17, 23, 25, 27
1.8	1, 3, 5, 9, 17, 33
1.9	1, 3, 5, 15, 17, 19, 21, 37

Class Policies and Suggestions

- 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!
- Attendance is not required, but is highly recommended. If you have to miss class, read the relevant section of the textbook and try the suggested problems, and ask a classmate for notes and information you may have missed. I do not keep detailed lecture notes for this course.
- I will attempt to return emails as quickly as possible (within 24 hours). However, it is better to ask complicated questions during class or in office hours. If you have a question about the homework, it is quite likely someone else has the same question, so you're doing the class a favor by asking.
- 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/
- I do not have a "no electronics" policy, but please remember to mute all devices during lecture, and use devices in a way that does not distract other students in the class.
- You will not need a calculator for this course, nor will you be permitted to use one on exams.
- You will be allowed to listen to music (with headphones) during exams, but please keep the volume at a level that does not distract other students. Plan a playlist in advance - your phone/player will need to be kept face down on the desk throughout the exam.
- While you are encouraged to work together on the homework, be sure you understand all material on your own before a quiz or exam.

Learning Differences

In keeping with college policy, any student with a disability who needs academic accommodations must call Learning Differences Program secretary at 824-3017, to arrange a confidential appointment with the director of the Learning Differences Program during the first week of classes.

Mercy Mission

This course supports the mission of Mercyhurst University by creating students who are intellectually creative. Students will foster this creativity by: applying critical thinking and qualitative reasoning techniques to new disciplines; developing, analyzing, and synthesizing scientific ideas; and engaging in innovative problem solving strategies.