Course Information

Description

This course is a one semester course in linear algebra with computer applications. The class lectures will focus primarily on definitions and theory, with some simple calculations being performed without the aid of a computer. Applications will be explored with the use of the Python programming language.

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.

Objectives

In this course, you will learn 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, and understand their use in applications.

Prerequisites

Success in Calculus I is recommended for this course, but a strong grasp of algebra and an appreciation for abstract mathematics is all that is required. Please see me if you have any questions. Programming experience is not required.

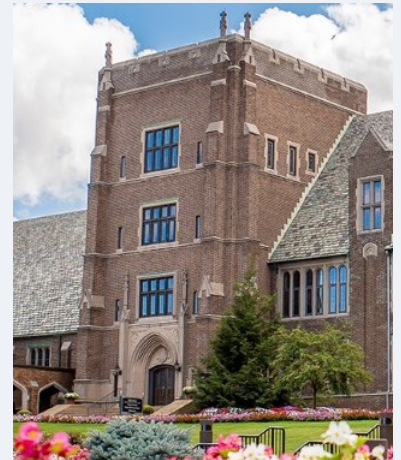### Section Information

MTWF 2 - 2:50
Hirt 214
4 Credits

Instructor

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

Office Hours

Monday 10 - 11
Tuesday 9 - 11
Tuesday 1 - 1:50
Wednesday 10 - 11
Friday 10 - 11
and by appointment

Office Hours

Drop in with any questions or just to chat during office hours - no appointment or notice required. If you need to meet with me outside those times, please email me to arrange a time. Zoom appointments on evenings and weekends are also possible with prior notice.
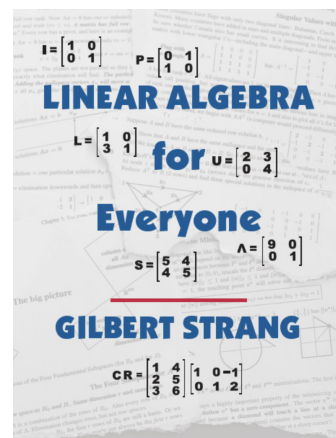
Textbook

Linear Algebra for Everyone, 1st Edition
by Gilbert Strang
ISBN 978-1-7331466-3-0

A website for this book, including purchasing information, a full solution manual, errata, and links to additional resources is available here:
https://math.mit.edu/~gs/everyone/

Grading

| Quizzes 30% | Exams 50% | Final Exam 20% |

Quizzes 30%

- Lowest quiz grade, including a missed quiz, will be dropped when calculating your quiz average
- Based on recommended homework problems and class examples
- Will not include material from the "lab" examples
- In person and closed book

Exams 50%

- Three unit exams of equal weight towards grade
- Lowest exam grade replaced by average of other two
- Not cumulative (within reason)
- In person and closed book

Final Exam 20%

- Wednesday, December 14, 1 - 3 pm
- Cumulative
- Required, regardless of current course grade
- Based on homework and class examples
- In person and closed book

Mathematics Department Grading Scale

F	D	D+	C	C+	B	B+	A
0%	60%	67%	70%	77%	80%	87%	90%

Attendance and Make Up Policies

- Attendance is not required, but highly encouraged. You do not need to notify me of an absence *unless* you will be missing a quiz or exam.

- If you know ahead of time that you will not be able to attend class on the date of a quiz or exam, please make arrangements for an alternative time with me *before* that day.

- Make ups will generally need to be completed before the next class meeting. For a quiz or exam given on a Wednesday, you will need to complete the assessment by the following Friday at noon. This will give me the opportunity to return graded work to the entire class promptly. Please see me if you have any extended absences.

Tips for Success

- Attend class whenever possible. Attendence is not required nor part of your grade, but is instrumental in keeping up with material and remaining engaged in the class.

- Give it time. You're expected to spend approximately 12-15 hours per week on this course, *in addition* to class meetings. Some students will need to devote more time to the course than others. Mathematics is not a fast subject to learn, and requires a lot of practice. Work on a few problems each day, and don't leave it all for the night before an exam.

- Find motivation. Linear algebra can be useful in *any* field, and knowing how it fits into your intended career can help you push through the inevitable obstacles you'll face in the course.

- Skim through relevant sections in the textbook before the class lectures. This will help in your understanding of the lectures, and alert you to any topics you'll need to focus on while in class.

- Form a study group with other people in the class. You may not need to meet regularly, but work on arrangements (where/when/how) *before* you need to.

- Mathematics is naturally cumulative. You will not be able to find and simplify a derivative without strong algebra skills, for instance. When you're having trouble with a problem, try to determine exactly where you're having the problem and review earlier sections in the book as needed.

- Construct a reference sheet with definitions, important theorems, and useful formulas. Add to it throughout the semester, and keep it nearby when working on homework. Keep practicing until you no longer need your sheet.

- If you're stuck on homework problems or lecture material, come to office hours with questions. You should make an attempt to work on any problems on your own or with a classmate first. I will fully explain any problems that will not be collected as part of an assignment, and give suggestions for graded problems.

Academic Honesty

- Your grade in this class should be a reflection of your understanding of the material. Academic dishonesty is a disservice to your classmates, instructors, future employers and colleagues, and ultimately, yourself.

- You may not use any notes, textbooks, or electronic devices of any kind (calculator, phone, computer, smart watch, etc) on quizzes or exams.

- You may not use the work of another classmate, with or without their knowledge, on quizzes or exams. This includes communicating during the assessment or simply copying from a nearby classmate.

- The first instance of academic dishonesty in this class will result in a grade of 0 on that assessment. This 0 will not be dropped or replaced as a low or missed grade, meaning your final grade will be impacted.

- A second or further instance of academic dishonesty will result in a report to the University as well as an F in this course if you remain enrolled past the withdrawal deadline.

University Policies and Information

Food and Drink 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 preferably a straw) is permitted to be used in classrooms and labs.

ADA

Mercyhurst University values inclusion and is committed to the goal of providing equal opportunities for all. Mercyhurst abides by federal, state, and local laws in admissions, employment, academic programs, and all services provided. Mercyhurst University is committed to complying with its obligations under the Americans with Disabilities Act (ADA), Section 504 of the Rehabilitation Act and the Fair Housing Act to ensure that a person with a disability is granted reasonable accommodations, when such accommodations are necessary, to afford that person equal opportunity to obtain a Mercyhurst education and use university facilities. Please refer to the HUB

https://lakersmercyhurst.sharepoint.com/sites/StudentsHub

and select the Services tab, then ADA Accommodations from the dropdown for instructions to request an accommodation. You may also contact Susan Reddinger, ADA Coordinator, ADA@mercyhurst.edu, 814-824-2362, Egan Hall 200. For students with questions about Academic Support, please refer to the HUB

https://lakersmercyhurst.sharepoint.com/sites/StudentsHub

and select the Academic Resources tab, then Academic Support for more information.

Title IX Information

Mercyhurst is committed to providing an environment free from sex discrimination, including sexual harassment and sexual violence. Please refer to the HUB:

https://lakersmercyhurst.sharepoint.com/sites/StudentsHub

and select the Resources tab, then Title IX – Sexual Respect from the dropdown for more information. If you would like to file a sexual misconduct complaint, please contact Ann Miller, Title IX Coordinator and Compliance Officer, titleix@mercyhurst.edu, 814-824-2363. 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).

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.

Course Schedule

MONDAY	TUESDAY	WEDNESDAY	FRIDAY
No Class	*No Class*	**Aug 24** *First Class Meeting* Class Overview	**Aug 26** Section 1.1 Linear Combinations
Aug 29 *Add-Drop Deadline* Section 1.1 Linear Combinations	**Aug 30** Section 1.2 Lengths and Angles	**Aug 31** Section 1.2 *Quiz* Lengths and Angles	**Sep 2** Lab Intro to Python
Sep 5 *No Class* Labor Day	**Sep 6** Section 1.3 Matrices	**Sep 7** Section 1.3 *Quiz* Matrices	**Sep 9** Section 1.4 Matrix Multiplication
Sep 12 Section 1.4 Matrix Multiplication	**Sep 13** Section 1.4 Matrix Multiplication	**Sep 14** Section 2.1 *Quiz* Idea of Elimination	**Sep 16** Lab Check Digits
Sep 19 Section 2.1 Idea of Elimination	**Sep 20** Section 2.2 Elimination, Inverse Matrices	**Sep 21** Exam	**Sep 23** Section 2.2 Elimination, Inverse Matrices
Sep 26 Section 2.2 Elimination, Inverse Matrices	**Sep 27** Lab Transition Matrices	**Sep 28** Section 2.3 *Quiz* Matrix Computations	**Sep 30** Section 2.3 Matrix Computations
Oct 3 Section 2.4 Permutations, Transposes	**Oct 4** Section 3.1 Vector Spaces & Subspaces	**Oct 5** Section 3.1 *Quiz* Vector Spaces & Subspaces	**Oct 7** Section 3.2 Nullspace and $A\vec{x} = \vec{0}$
Oct 10 Section 3.2 Nullspace and $A\vec{x} = \vec{0}$	**Oct 11** Lab Leslie Models	**Oct 12** Section 3.3 *Quiz* Solutions of $A\vec{x} = \vec{b}$	**Oct 14** *No Class* Mid Semester Break
Oct 17 Section 3.3 Solutions of $A\vec{x} = \vec{b}$	**Oct 18** Section 3.4 Basis and Dimension	**Oct 19** Section 3.4 *Quiz* Basis and Dimension	**Oct 21** Section 3.4 Basis and Dimension
Oct 24 Section 3.5 The Four Subspaces	**Oct 25** *Registration Starts* Section 4.1 Orthogonality	**Oct 26** Exam	**Oct 28** Section 4.2 Projections
Oct 31 Section 4.3 Least Squares	**Nov 1** *No Class* Advising Day	**Nov 2** Section 4.4 *Quiz* Gram-Schmidt	**Nov 4** Section 4.4 Gram-Schmidt
Nov 7 Section 5.1 3×3 Determinants	**Nov 8** Section 5.1 3×3 Determinants	**Nov 9** Section 5.2 *Quiz* Properties of Determinants	**Nov 11** *Pass-Fail Deadline* Section 5.2 Properties of Determinants
Nov 14 Section 5.3 Linear Transformations	**Nov 15** Section 5.3 Linear Transformations	**Nov 16** Section 6.1 *Quiz* Intro to Eigenvalues	**Nov 18** *Withdraw Deadline* Section 6.1 Intro to Eigenvalues
Nov 21 Lab Spectral Clustering	**Nov 22** Section 6.2 Diagonalization	**Nov 23** *No Class* Thanksgiving Break	**Nov 25** *No Class* Thanksgiving Break
Nov 28 Section 6.3 Symmetric & Positive Definite	**Nov 29** Section 6.3 Symmetric & Positive Definite	**Nov 30** Exam	**Dec 2** Section 7.1 Singular Value Decomposition
Dec 5 Lab Image Compression	**Dec 6** Section 7.3 Principal Component Analysis	**Dec 7** Section 7.3 Principal Component Analysis	**Dec 9** *Last Class Meeting* Semester Review
Dec 12 *Finals Week*	**Dec 13** *Finals Week*	**Dec 14** *Finals Week* Exam	**Dec 16** *Finals Week*

Homework List

Your homework will not be collected, but problems similar to these are likely to appear on quizzes and exams.

Problems marked * are highly recommended (especially for math majors!), but will not appear on a quiz or exam.

A full solution manual is freely available on the textbook site. Please use it sparingly - you should be able to work these problems on your own. Try to only use the solutions to check your work. If you're stuck on a problem, ask about it in class or come to office hours.

Section	Page	Problems
1.1	8	3, 4, 5, 6, 9, 11, 16, 23*
1.2	16	1, 2, 3, 5, 7, 11*, 12, 13, 18*
1.3	26	1, 4, 7, 8*, 9, 10, 12, 14, 16*
1.4	35	3, 4, 5, 6, 7, 13, 17*
2.1	46	1, 5, 6, 7, 10, 11*, 18, 19, 20
2.2	53	1, 3, 12, 15, 19, 20, 21*, 23*, 26, 28*, 33*
2.3	61	2, 3, 9, 10
2.4	71	1, 2, 4*, 7, 8, 16, 22*
3.1	79	4, 5, 9, 14, 15*
3.2	91	2, 4, 6, 7, 11*, 15
3.3	103	1, 4, 9, 12, 18, 20, 23, 24, 32*
3.4	116	1, 2, 5, 6, 9, 13, 16, 36
3.5	129	2, 3
4.1	141	No problems assigned
4.2	150	1, 3, 8, 22, 29*
4.3	162	1
4.4	174	2, 6, 16*, 20, 21
5.1	181	1, 2, 3, 9, 12*, 13, 18
5.2	190	1, 2, 3, 5, 7*, 10, 12
5.3	199	1*, 2, 3, 5, 7, 15, 16*, 19*
6.1	211	2, 3, 4, 5, 8, 17, 21, 24, 25
6.2	223	1, 2, 4, 11, 12, 13*
6.3	238	2, 4, 5, 25, 26, 32, 37*
7.1	267	1, 12
7.3	279	1*, 2*