MSSC 6040 – Applied Linear Algebra – Fall 2024

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Lectures: MW 5-6:15pm, Cudahy Hall

Course Website: https://d2l.mu.edu/d2l/home/563703

Office Hours: 367 Cudahy Hall, Wed 4-5 pm & Fri 9:30-10:30 am, and by appointment if necessary

Course Description

The main theme of this course is foundational linear algebra considered from a numerical viewpoint. We focus on solutions of linear systems of equations, eigenvalues and eigenvectors, and transformations. The course emphasizes and illustrates proof and numerical implementation using problems arising in applications. Multivariable calculus and linear algebra are prerequisites.

Textbook

Required: *Numerical Linear Algebra* by Lloyd N. Trefethen and David Bau, III. SIAM, 1997.

I will also occasionally post additional notes and supplementary materials on D2L. You are not responsible for textbook material or any other material that is not covered in lecture.

Assessments

Grading Scale

Grades will be based on **homework** (50% of final grade), **quizzes** (10% of final grade), a **midterm exam** (15% of final grade), and a **final exam** (25% of final grade).

Letter grades will be assigned using the following scale:

A	$93\% \leq$ Percentage $\leq 100\%$	**C**	$73\% \leq$ Percentage $< 77\%$
A-	$90\% \leq$ Percentage $< 93\%$	**C-**	$70\% \leq$ Percentage $< 73\%$
B+	$87\% \leq$ Percentage $< 90\%$	**D+**	$67\% \leq$ Percentage $< 70\%$
B	$83\% \leq$ Percentage $< 87\%$	**D**	$60\% \leq$ Percentage $< 67\%$
B-	$80\% \leq$ Percentage $< 83\%$	**F**	Below 60% Percent
C+	$77\% \leq$ Percentage $< 80\%$		

Homework

- Homework will be due roughly every 2 weeks, and will consist of a mix of textbook problems and MATLAB coding exercises.
- All homework will be submitted virtually to a D2L dropbox. **Your homework must be uploaded as a single pdf file.** If you are hand-writing your solutions, there are several free apps to help with this, including Genius Scan and CamScanner among others. Please make sure your scanned homework is legible before uploading. Scanned homework that cannot be read or that is uploaded as multiple files and/or in the wrong format (i.e., not a single pdf) will not be graded and given an automatic zero. Occasionally, you may need to merge pdfs before uploading to D2L. There are several free online apps to do this as well, such as combinepdf.com.
- **Collaboration Policy**: It can be very helpful to study and work with a group. This type of cooperative learning is encouraged. However, be sure that you have a thorough understanding of the concepts as well as the steps used to solve an exercise. You must be able to work through the exercises on your own. Each student must write up their assignment individually and independently and must turn in their own work.
- It is acceptable to consult external resources, including the internet and generative AI tools like ChatGPT, to get a better high-level understanding of topics in this course (e.g., looking at the wikipedia page for the SVD, or prompting ChatGPT with "example of how to use SVD command in MATLAB"). **It is not acceptable to copy solutions or code from these external resources. Solutions copied from the web or from generative AI tools, in whole or part, will receive an automatic zero.** If you are unsure about whether it is ok to use an insight obtained from an external resource on the homework (e.g., a linear algebra fact not covered in lecture) **ask me in advance of turning in your assignment**. Otherwise your work may be flagged for plagarism.
- No late work will be accepted. However, **your single lowest homework score will be dropped at the end of the semester.**

Quizzes

- At the end of each class period, I will assign a D2L quiz consisting of one short answer question that will be due before the next class period.
- Each quiz is pass/fail. You may update your answer as many times as you like before the deadline, but only your final answer will be graded.
- No late submissions are accepted. However, **your three lowest quiz scores will be dropped at the end of the semester.**

Exams

- There will be one midterm exam and a comprehensive final.
- The midterm exam will be in-person and taken during regular class period. If you are unable to attend class on the day of the midterm due to illness or an emergency, please let me know as soon as possible.
- The final exam will be a take-home exam and due by upload to a D2L dropbox. You will have roughly one week to complete the exam.
- Make-up exams will not be given unless the student informs, and has a come to a written agreement with, the instructor regarding the absence no later than the day before the exam day. The student is responsible for scheduling their make-up exam.

Course Technology

MATLAB

- Several assignments will use the MATLAB computing toolbox. However, no previous experience with MATLAB is expected or required.
- There are several ways to use MATLAB. Marquette University students may download and install MATLAB onto their personal computers for free: https://techsquad.mu.edu/support/solutions/articles/21001160044. An online version of MATLAB that works in the browser is also available at: https://matlab.mathworks.com/. Finally, MATLAB is also installed on computers in the computer labs of Cudahy Hall and in Engineering and the library.
- Some homework assignments will make use of the **Image Processing Toolbox**. To add this toolbox to your MATLAB installation, click on the "APPS" tab at the top of the interface, then click the "Get More Apps" button, and search for "Image Processing Toolbox".
- Ensure you have access to MATLAB by the end of the first week of classes at the latest. Please contact ITS with questions about downloading and installing MATLAB on your device.

LaTeX

- LaTeX (pronounced "lay-tech" or "law-tech") is a text editor that enables you to create professional-looking mathematical documents. It is very commonly used in mathematics, computer science, physics, engineering, and other STEM fields. **I highly recommend typesetting your homework in LaTeX, though it is not required.** Overleaf (https://www.overleaf.com/) is a free, easy-to-use, online LaTeX editor (and is, in fact, what I used to create this document).
- I have posted some tutorial information and templates on D2L to help you get started, and I'm always more than happy to help out in office hours.
- Along with each homework assignment, I will share the LaTeX source on Overleaf that you can use to start from, so you don't need to retype the problem statements.

Course Policies

Attendance Students are expected to attend the in-person lectures. However, I realize that this may not be possible for all students at all times. If a class is missed, the student is responsible for getting lecture notes from a classmate. In the event of a prolonged absence due to illness or other exceptional circumstances, please contact me as soon as possible so that I can make reasonable accommodations, especially if the absence includes an exam date.

Grading Disputes If you believe that I have made an error in scoring an assignment, you must bring it to my attention **within one week** of the graded assignment being returned. I will carefully reread, and if necessary rescore, the assignment.

Accommodations for Disabilities If you have a disability and will require accommodations under the Americans with Disabilities Act, you need to provide appropriate documentation to the Office of Disability Services. They will supply you with a letter to give to me detailing the accommodations. If you are unsure of whether you qualify for services, visit the Office of Disability Services' website, http://www.marquette.edu/disability-services, or contact them at (414) 288-1645. If you qualify for special accommodations you must work with the course instructor and come to an agreement no less than 7 days prior to the needed accommodation.

Course Schedule

Note: The schedule below is tentative and subject to change.

Mon, Aug 26	Syllabus, Lecture 1 - Linear Algebra Review
Wed, Aug 28	Lecture 1, Cont.
Mon, Sept 2	No class – Labor Day
Wed, Sept 4	Lecture 1, Cont.
Mon, Sept 9	Lecture 2 - Orthogonal Vectors and Matricies
Wed, Sept 11	Lecture 2, Cont.
Mon, Sept 16	Lecture 3 - Norms
Wed, Sept 18	Lecture 4 - Singular Value Decomposition (Part I)
Mon, Sept 23	Lecture 5 - Singular Value Decomposition (Part II)
Wed, Sept 25	Supplement - Applications of the SVD: Eigenfaces
Mon, Sept 30	Eigenfaces, Cont. & Lecture 6 - Projectors
Wed, Oct 2	Lecture 6, Cont.
Mon, Oct 7	Lecture 7 - QR Decomposition
Wed, Oct 9	Lecture 8 - Gram-Schmidt Orthgonalization
Mon, Oct 14	Midterm Review
Wed Oct 16	In-class Midterm Exam
Mon, Oct 21	Lecture 11 - Least Squares Problems
Wed, Oct 23	Lecture 11, Cont. & Supplement: Regularized LS
Mon, Oct 28	Supplement: Regularized LS, Cont.
Wed, Oct 30	Supplement: Regularized LS, Cont.
Mon, Nov 4	Lecture 12, 18 - Conditioning
Wed, Nov 6	Lecture 14, 15, 19 - Stability
Mon, Nov 11	Lecture 20-23 - Direct Methods for Solving Linear Systems: Overview
Wed, Nov 13	Lecture 20-23, Cont.
Mon, Nov 18	Lecture 32 - Iterative Methods for Solving Linear Systems: Overview
Wed, Nov 20	Lecture 38 - Conjugate Gradients
Mon, Nov 25	No class – Thanksgiving Break
Wed, Nov 27	No class – Thanksgiving Break
Mon, Dec 2	Lecture 24,25,27 - Eigenvalue Problems, Cont.
Wed, Dec 4	Lecture 24,25,27 - Eigenvalue Problems Take-home Final Exam assigned
Wed, Dec 11	Take-home Final Exam due by upload to D2L, 11:59 pm.