MTH 415: Applied Linear Algebra
Class: MWF 1:50 - 2:40pm, Wells Hall A318
Credit hours: 3

Instructor: Rongrong Wang, Ph.D. (She/her) wangron6@msu.edu
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Office Hours and Backup Class Zoom Link: Meeting ID: 91067342184, Passcode: 415001
Office Hours: Monday 2:45 pm–3:45 pm, Wells Hall C345
Wednesday 4 pm–5 pm (online)

Course Description:
This course develops mathematical tools from linear algebra that are useful in modern applied mathematics, scientific computing, data analysis, and machine learning. In particular, the material provides background for understanding topics such as feedforward and convolutional neural networks.
Topics include finite-dimensional inner product spaces, norms and related inequalities, unitary matrices, discrete Fourier transforms, convolution, the Fast Fourier Transform (FFT), the Singular Value Decomposition (SVD), least-squares regression, and linear inverse problems.

Course Objectives:
Course objectives: establish a rigorous mathematical foundation in linear algebra for machine learning.

1 Course Website

The course website is

https://users.math.msu.edu/users/wangron6/mth415_f26.html

Students should check the course website regularly. The website contains the course schedule, syllabus, supplementary reading materials, and homework assignments.

2 Textbook and Course Notes

There is no required commercial textbook for the course. We will primarily use course notes prepared by the instructor. The relevant notes will be posted or linked from the course schedule.

Pre-requisites:
(MTH 234 or MTH 254H or LB 220) and (MTH 309 or MTH 314 or MTH 317H) and (CMSE 201 or CSE 231) Not open to students with credit in: MTH 414)

Textbook:

- Strang, G. *Linear Algebra and Learning from Data*. Wellesley–Cambridge Press, 2019.
- Meyer, C. D. *Matrix Analysis and Applied Linear Algebra*. SIAM, 2001.
- Trefethen, L. N., and Bau, D. III. *Numerical Linear Algebra*. SIAM, 1997.

3 Homework

Homework will be assigned during most weeks of the semester and will account for **50%** of the final course grade.
Please complete the homework with minimal assistance from AI tools. To help ensure that students understand and can independently solve the assigned problems, we will use the last 10 minutes of each Friday lecture for a short quiz containing a problem similar to one of the homework problems submitted that or the previous week. The final homework grade will be calculated by multiplying the raw homework grade by the quiz score expressed as a percentage.
Assignments and due dates will be posted on the course website. New assignments will also be announced in class.
Unless prior arrangements have been made, homework must be submitted during class on the stated due date. Late homework will not be graded.
The two lowest homework scores will be dropped when computing the final homework average.
Homework solutions must be prepared individually and submitted either

- in the student's own handwriting, or
- as a document compiled using LaTeX.

Solutions should be clearly written and sufficiently detailed to receive full credit.

4 Midterm Exam

There will be one in-class midterm examination:

Friday, October 16, 2026

The midterm examination will account for **20%** of the final course grade.

5 Final Exam

The final examination will be held on

Wednesday, December 16, 2026
5:45 pm–7:45 pm

The final examination will account for **30%** of the final course grade.

6 Grading

The final numerical course percentage will be computed using the following weights:

Component	**Weight**
Homework	50%
Midterm Exam	20%
Final Exam	30%

The resulting weighted percentage will be rounded to the nearest integer.
Final course grades will be determined using the distribution of scores in the class. The cutoff for each grade will not be higher than the values shown below.

Percentage	Letter Grade	MSU Grade
90–100%	A	4.0
85–89%	A-/B+	3.5
80–84%	B	3.0
75–79%	B-/C+	2.5
70–74%	C	2.0
65–69%	C-/D+	1.5
60–64%	D	1.0
0–59%	F	0.0

7 Incomplete Grades

An incomplete grade will be assigned only in unusual circumstances, such as a serious illness or personal emergency that prevents a student from completing a substantial portion of the course. An incomplete cannot be assigned simply as an alternative to an otherwise earned course grade.

8 Academic Integrity

Students are encouraged to discuss homework problems and mathematical ideas with their classmates. However, all submitted solutions must be written independently and in the student's own words.
Submitting another student's written work as one's own constitutes plagiarism. Likewise, submitting AI-generated solutions as one's own work is considered a violation of academic integrity.
Students are expected to follow Michigan State University's policies on academic integrity throughout the course.

Tentative Schedule:

Topic	Number of Lectures
Motivation	2–4
Review of basic linear algebra	4-5
SVD, pseudoinverse, PCA, and low-rank approximation, least squares	10–12
Gradient methods and conjugate gradient	5
Kaczmarz and SGD	2–4
Convolution	2
Fourier transform and FFT	4–5

Table 1: Tentative course schedule.

Inclusive classroom behavior:

Respectful and responsible behavior is expected at all times, which includes not interrupting other students, refraining from non-course-related use of electronic devices or additional software during class sessions, and not using offensive or demeaning language in our discussions. Flagrant or repeated violations of this expectation may result in ejection from the classroom, grade-related penalties, and/or involvement of the university Ombudsperson. In particular, behaviors that could be considered discriminatory or harassing, or unwanted sexual attention, will not be tolerated and will be immediately reported to the appropriate MSU office (which may include the MSU Police Department).

In addition, MSU welcomes a full spectrum of experiences, viewpoints, and intellectual approaches because they enrich the conversation, even as they challenge us to think differently and grow. However, we believe that expressions and actions that demean individuals or groups comprise the environment for intellectual growth and undermine the social fabric on which the community is based. These demeaning behaviors are not welcome in this classroom.

Accommodations for Students with Disabilities:

(from the Resource Center for Persons with Disabilities (RCPD): Michigan State University is committed to providing equal opportunity for participation in all programs, services and activities. Requests for accommodations by persons with disabilities may be made by contacting the Resource Center for Persons with Disabilities at 517-884-RCPD or on the web at http://rcpd.msu.edu. Once your eligibility for an accommodation has been determined, you will be issued a Verified Individual Services Accommodation ("VISA") form. Please present this form to the instructor at the start of the term and/or two weeks prior to the accommodation date (test, project, etc.). Requests received after this date may not be honored.

Academic honesty:

Intellectual integrity is the foundation of the scientific enterprise. In all instances, you must do your own work and give proper credit to all sources that you use in your papers and oral presentations – any instance of submitting another person's work, ideas, or wording as your own counts as plagiarism. This includes failing to cite any direct quotations in your essays, research paper, class debate, or written presentation. The MSU College of Engineering adheres to the policies of academic honesty as specified in the General Student Regulations 1.0, Protection of Scholarship and Grades, and in the all-University statement on Integrity of Scholarship and Grades, which are included in Spartan Life: Student Handbook and Resource Guide. Students who plagiarize will receive a 0.0 in the course. In addition, University policy requires that any cheating offense, regardless of the magnitude of the infraction or punishment decided upon by the professor, be reported immediately to the dean of the student's college. (See also the Academic Integrity webpage.)

It is important to note that plagiarism in the context of this course includes, but is not limited to, directly copying another student's solutions to assignments; copying materials from online sources, textbooks, or other reference materials without citing those references in your source code or documentation, or having somebody else do your in-class work or homework on your behalf. Any work that is done in collaboration with other students should state this explicitly, and have their names as well as yours listed clearly.

More broadly, we ask that students adhere to the Spartan Code of Honor academic pledge, as written by the Associated Students of Michigan State University (ASMSU):

"As a Spartan, I will strive to uphold values of the highest ethical standard. I will practice honesty in my work, foster honesty in my peers, and take pride in knowing that honor is worth more than grades. I will carry these values beyond my time as a student at Michigan State University, continuing the endeavor to build personal integrity in all that I do."

Limits to confidentiality:
Essays, journals, and other materials submitted for this class are generally considered confidential pursuant to the University's student record policies. However, students should be aware that University employees, including instructors, may not be able to maintain confidentiality when it conflicts with their responsibility to report certain issues to protect the health and safety of MSU community members and others. As the instructor, I must report the following information to other University offices (including the Department of Police and Public Safety) if you share it with me:

- suspected child abuse/neglect, even if this maltreatment happened when you were a child,
- allegations of sexual assault or sexual harassment when they involve MSU students, faculty, or staff, and
- credible threats of harm to oneself or to others.

These reports may trigger contact from a campus official who will want to talk with you about the incident that you have shared. In almost all cases, it will be your decision whether you wish to speak with that individual. If you would like to talk about these events in a more confidential setting you are encouraged to make an appointment with the MSU Counseling Center.