MAT167 Syllabus

Applied Linear Algebra
Dr. Melissa Zhang
CRN 62202

Spring Quarter 2023

1 Course information

Course meetings Lectures MWF 2:10–3:00 pm, Olson Hall 106

Prerequisites MAT 022A or MAT 027A or MAT 067 or BIS 027A

Text Lars Eldén: Matrix Methods in Data Mining and Pattern Recognition, SIAM, 2007
https://doi.org/10.1137/1.9780898718867
ISBN: 978-0-898716-26-9

- This ebook is available to UC Davis students for free, as UC Davis has a SIAM subscription.

Instructor Dr. Melissa Zhang (mlzhang@ucdavis.edu), MSB 2145

- You may call me "Dr. Zhang". To pronounce my last name, choose your own comfort level:
  Level 1 *Doctor Zang* (rhymes with "hang")
  Level 2 *Doctor Djong* (rhymes with "gong")
  Level 3 https://en.wikipedia.org/wiki/Zhang_(surname)
- I generally handle my emails once daily, on business days. As such, if you email me, you can expect a response from me within 1-2 business days.

Instructor office hour: MSB 2145, Tuesdays 2 pm – 3 pm

- If you want to speak privately during office hours (e.g. about your grades), let me know. If you want to meet with me individually outside of office hours, please make an appointment by email at least 24 hours in advance.

Teaching assistant (TA): Xuxing Chen (xuxing@math.ucdavis.edu), MSB 3131

TA office hours: MSB 3131, Wednesdays 9 am – 12 noon

Website: https://www.melissa-zhang.com/Teaching/SQ2023/MAT167.html

Course Drop Date: April 28, 2023 (20 Day Drop)

2 Course description

Course description Data mining and pattern recognition are two major themes in modern data science. To solve problems in these areas, data scientists use various linear algebra techniques (such as Singular Value Decomposition) and scientific computing tools (such as MATLAB). In this course, students will strengthen their foundations in linear algebra, develop a working familiarity with MATLAB, and explore a selection of powerful linear algebra tools along with example applications to data science.

Learning goals Mastery of this course is determined by students' abilities in the following areas:

- understanding basic linear algebra and the underlying meaning of matrices, vectors, and their operations and manipulations
- knowledge of and computational fluency with presented techniques and algorithms.

In other words, for each technique, algorithm, or concept presented, students are expected to (1) readily recall and apply the technique in a calculation or computation, and (2) understand why the technique is appropriate for the problem at hand and when to use the technique.

Tentative course outline Below is a rough outline of the topics covered in the course. The book chapters come from the class textbook. The topics listed are those we will focus most heavily on within the listed chapters.

Week	Book Chapters	Topics
1	1, extra material	Motivational introduction with examples; Review of basic linear algebra: meaning of matrix-vector/matrix-matrix multiplications
2	2	Review of basic linear algebra: range; null space; linear independence; bases; dimensions; ranks; inverse matrices; inner products; vector and matrix norms
3	3.6, 4, 5	Introductory least squares problems; orthogonality; projectors; QR factorization; classical Gram-Schmidt orthogonalization
4	5	Modified Gram-Schmidt; Householder triangularization; Givens rotations
5	6	Introduction to Singular Value Decomposition (SVD)
6	6, 7	Low rank approximation; condition numbers; SVD vs Principal Component Analysis
7	9	Data clustering; Nonnegative Matrix Factorization
8	10	Applications of SVD I: pattern classification
9	11	Applications of SVD II: text mining
10	12, extra material	Applications of SVD III: search engines

The **class calendar** is available at the course website and will be continually updated throughout the quarter to reflect changes in the scheduled lessons.

Disclaimer: The course syllabus is a general plan for the course; deviations announced to the class by the instructor may be necessary. It is the responsibility of the student to seek clarification of the grading policy and/or course requirements and procedures from the instructor.

3 Assignments and grading

Your numeric grade will be calculated using the following weights. Each assignment type will be discussed further below.

In-class work / participation	20%
Homework	40%
Midterm Exam	15%
Final Project	25%
Total	100%

In-class work / participation At the beginning of each class, there will be a short review problem to work on. You will work on this problem with your peers sitting around you, and then submit your work at the end of class. These assignments will serve as a record of your class attendance, and your effort on these assignments will be taken into consideration while grading.

- Grading of these assignments will begin at Week 3, which is after the last day to add this course.
- There is no way to make-up these collaborative assignments. If there are documented extenuating circumstances preventing you from completing these assignments or attending lectures, contact me and we can discuss a modified plan.

Homework: Homeworks will be due weekly on **Thursday nights at 11:59 pm, on Gradescope**. Your homeworks must be **neat**. For example, the order of your solutions in your homework should be the same as listed in the problem set. If you are scanning hand-written solutions to Gradescope, check that your scans are readable before submitting. The graders are instructed to **deduct style points** if solutions are unclear, or if solutions are illegible.

- I will drop your lowest homework score at the end of the semester.
- You are allowed **two 24-hour extensions to use on homework(s) of your choice**; you must indicate on Gradescope that you are using this extension, on the homework you use it on. No other extensions will be granted except in documented extenuating circumstances.
- No other extensions/drops will be granted, except in documented extenuating circumstances. **All assignments must be submitted by the last day of class, June 8, 2023.**

Midterm exam: There will be one in-class midterm exam, currently scheduled for **Friday, April 28, 2023**.

- This exam will be a traditional pencil-and-paper exam, taken during lecture time in our usual classroom.
- If you for any reason are unable to take the midterm exam, your grade for the midterm exam will be replaced by your grade on the final project.

Final project: The "final exam" for this course is technically scheduled for *Friday, June 15, 2023 at 6:00 PM*. This date and time is scheduled by the University and cannot be changed.

However, for this course, the final exam will instead be a final project, due on the last day of class, **Thursday, June 8, 2023 at 11:59 pm.**

- To see your personal final exam schedule, go to

  https://registrar.ucdavis.edu/registration/register-for-classes/finals

  In particular, the University policy states:

  > *Students wishing to adjust their final exam schedule because of multiple exams on the same day must make arrangements with the instructors of the courses. Students are responsible for ensuring they do not have conflicting exams. There is no regulation mandating a change.*

Letter grades: At the end of the semester, letter grades will be assigned using the following scale:

< 60	$60-62$	$63-66$	$67-68$	$69-71$	$72-76$	$77-78$	$79-81$	$82-86$	$87-89$	$89-91$	≥ 92
F	D-	D	D+	C-	C	C+	B-	B	B+	A-	A

- The assigned letter grade will be a lower bound for your final recorded grade. For example, any numerical grade x within the range $82 \leq x < 87$ translates to a grade of at least B. You should count on receiving the letter grade indicated by the chart.
- Note that “rounding up" has already been built into the grading scale. Requests to further round up at the end of the semester will be denied.

4 Course policies and procedures

Diversity and inclusion statement: In this classroom, you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class. (Source: modified from https://docs.asee.org/public/LGBTQ/Diversity_Statement.pdf)

Classroom expectations: We will discuss mathematics together on a daily basis. These discussions are important because they provide for a richer classroom discussion, and they ensure that we all encounter different ways – correct and/or incorrect – of thinking about the material. It will be important for you to listen attentively to your peers' thinking, even if you think you already have a full solution to the discussion problem. I expect you to respond respectfully and carefully to your peers' comments. When you are working in groups, I expect you to help your group members to all work at the same pace; it will be important for you to keep your peers informed about the choices you are making, and for you to check in with them to make sure they follow your thinking and are ready to move on.

Electronics policy: Cell phones may not be used in class. Laptops, tablets, etc. may be used only for note-taking or other class-related activities, during class. I understand that there may be times when you need to be connected (childcare issues, family emergencies, etc.). If such a situation arises, please step outside and address these as needed. If you repeatedly violate this policy, you will be asked to leave the room immediately.

Academic honesty: See the UC Davis Code of Academic Conduct at

https://ossja.ucdavis.edu/code-academic-conduct

You are encouraged to discuss homework with others, but any solution that you hand in must be thought through and worked through on your own and written down in your own words.

Accessibility For accommodations for disabilities, go to

https://sdc.ucdavis.edu

and begin the process as soon as possible. I will need to approve a letter from the Student Disability Center before making any accommodating changes to the policies stated on this syllabus for you. It is the student's responsibility to make sure all accommodations are set up through the SDC ahead of exams or class meetings where accommodations are needed.