Syllabus for Math 314 Linear Algebra with Applications
Fall, 2020, University of New Mexico

Instructor: Prof. Jacob B. Schroder

Class meeting times:

1. Weekly Zoom problem sessions (required attendance)

1. Wednesday: 9:00am-9:50am
   https://unm.zoom.us/j/91402083069 *(See instructor for passcode)*

2. Weekly Lecture videos: Posted on course UNM Learn site

3. Zoom Drop-in Time for Students:

- Monday: 9:00am-9:50am
- Friday: 9:00am-9:50am
- By request
- Use Zoom link: https://unm.zoom.us/j/91402083069 *(See instructor for passcode)*

Course webpage: See UNM Learn, Math 314

Prerequisites:

1. Math 1440 or Math 1522
2. CS 151L or CS 152L or ECE 131L or PHYS 2415

Textbook: *Linear Algebra with Applications* by G. Williams, 9th Edition
→ Online textbook access with Learn automatic with course registration

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Important Dates:

- *University holidays Mon. Sept. 7, Wed. Oct. 7, Tues. Nov. 3, Thanksgiving Nov. 26 & 27*
- Exam 1: Sept. 16th (Wednesday)
- Exam 2: Oct. 14th (Wednesday)
- Exam 3: Nov. 11th (Wednesday)
- Exam 4: TBD, During Finals Week, Dec. 7-11, 2020

Course Description: This is an introductory course to linear algebra, with a focus on concepts, computational methods (via Matlab), and applications (e.g., curve fitting, electrical networks, traffic flow, etc.). The main concepts covered are (i) vectors, matrices, and vector spaces, (ii) systems of linear equations and Gaussian elimination, (iii) orthogonality and inner-product spaces, (iv) least squares, (v) eigenvalues, eigenvectors, and diagonalization, and (vi) associated Matlab matrix routines.

Grading: The course grade will be determined by

- Participation: 5%
- Homework: 19%
- Four exams (each worth 19%): 76%

The final grade for the class will be based on the summed weighted percentages above. Letter grades will be assigned as follows:

A- 90% or above B- 80% or above C- 70% or above D- 60% or above F- below 60%

The 5% participation grade will be based on attendance and participation during the weekly Wednesday Zoom meetings. Regular participation here will result in full participation credit. Participation during the student drop-in hours can serve as make-up participation points.

The instructor reserves the right to curve grades to offset unforeseen circumstances. Such a curve will never decrease a student's letter grade below that from the above scheme.

Exams: There are four equally weighted exams. All exams will be "take-home". A typical exam will be available on Learn by 7:30am, and due via Learn by 10:30am later that day. All exams are tentatively scheduled for a Wednesday (see below schedule). The exams will be designed to take 50 minutes, and the extra time is to give students from all three sections some flexibility.

Cheating on an exam will be handled according to the dishonesty policy below.

There are no makeup exams; however, I am sympathetic to a student who is unable to take a scheduled test due to a hardship (especially during this pandemic!). Please contact the instructor before the exam (if possible), should such a hardship occur.

Grading disputes must be submitted in writing within one week after the exam is returned.

Homework: Homework will be posted roughly every week on the course webpage. Each homework will consist of a number of computer and theoretical problems.

- Homework will, in general, ***be due on Monday by 6pm***.
- You need to hand in a written homework report on the due date via UNM Learn.
- See the course UNM Learn homework page for HW format details (PDF required).
- Homework may be submitted up to a week late for 50% credit. But, these are unusual times, and I want to be flexible when needed. If you need an accommodation, please contact me as soon as you know.
- Homework grading disputes must be submitted in writing within one week after the work is returned.

You are encouraged (but not required) to work in pairs (group of two students) for homeworks.
→ ***Hand in a single report on Learn with both collaborators cited at the top.***
→ It is expected that both of you can explain the theory and computer codes.
→ Groups of more than two students are not allowed.

Software: Use of MATLAB will be required to complete some course homework assignments.

Communication policy: Please use your UNM email or the twice weekly student drop-in Zoom sessions to communicate with me.

In order to comply with the Family Educational Rights and Privacy Act of 1974 (FERPA), UNM students must correspond with me using their UNM email account and/or the communication feature of our class learning management system (i.e., UNM Learn). To protect student privacy, I cannot respond with any information contained in educational records from emails received from non-UNM accounts. For information on FERPA, please visit http://ed.gov/policy/gen/guid/fpco/ferpa/students.html.

Course Goals:

- **Understand** linear equations, vectors, and matrices

- **Know** what vector spaces are and how to prove properties about them
- **Understand** how your new tools and knowledge connect to sample real-world examples
- **Know** how to use Matlab routines for solving linear algebra problems

Student Learning Objectives (SLOs):

- **Learn the foundations of linear algebra:** Basic matrix and vector manipulations, the four fundamental vector spaces of a matrix, linear independence, and abstract vector spaces. Be able to solve linear systems, least squares problems, eigenvalue problems, and diagonalize linear systems of differential equations.

- **Learn Mathematical writing.** Learn how to
    1. Write clear proofs, with a hypothesis, followed by a sequence of logical conclusions, terminating with the desired statement
    2. Work with fundamentals of logic, including mathematical statements, negation, converses, and contrapositives
    3. Prove with induction
    4. Communicate such proofs clearly, precisely, and logically

- **Learn Matlab fundamentals.** Learn how to use Matlab to
    1. Create matrices and vectors, and operate with them, e.g., for multiplication, addition, and solving linear systems
    2. Solve least squares systems and eigenvalue problems
- **Demonstrate proficiency with online learning techniques**: Learn how to collaborate effectively and engage in peer learning online with other students, e.g., with Zoom

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Tentative Schedule of Topics

Section 1.1	Matrices and systems of linear equations
Section 1.2	Gaussian and Gauss-Jordan elimination
Section 1.7	Applications, `RREF` in Matlab
Section 1.3	The vector space R^n and vector equations
Section 1.4	Subspaces of R^n
Section 1.5	Basis and dimension
Sections 2.1-2.2	Matrix operations (+, *), their properties, corresponding Matlab commands
Extra *(whiteboard)*	Describe and give examples of matrix equations, Introduction to proofs
Section 2.4	Matrix inverses and corresponding Matlab commands
	Exam 1, Wed. Sept. 16th Sections 1.1-1.5, 1.7, 2.1-2.2
Sections 2.4, 7.2	Elementary matrices and LU factorization, Matlab LU factorization
Section 2.5	Matrix transformations, rotations, and dilations
Section 2.6	Linear transformations and graphics
Sections 3.1, 3.2	Determinants and their properties, cofactor expansion, Matlab `Det()`
Sections 3.2, 3.3	Determinants, matrix inverses, and systems of linear equations
Section 3.4	Eigenvalues and eigenvectors
Section 5.3	Diagonalization of matrices, Matlab diagonalization [dot-product (Sect. 1.6)]
Section 5.5	Linear differential equations
Extra *(whiteboard)*	Show example differential equations and/or eigenvalue problems (Sect. 3.5)
	Exam 2, Wed. Oct. 14th Sections 2.4-2.6, 3.1-3.4, 5.3, 5.5
Section 4.1	General vector spaces and subspaces (possibly two lecture videos)
Section 4.2	Linear combinations of vectors

Section 4.3	Linear independence of vectors
Section 4.4	Bases of vector spaces and their properties
Section 4.5	Matrix row rank, matrix column rank, matrix null space, and nullity
Section 4.8	Transformations: Kernel, range, rank/nullity theorem
Section 4.9	One-to-One, onto transformations, and the inverse transformations
Section 5.1	Coordinate vectors
	Exam 3, Nov. 11th Sections 4.1-4.5, 4.8-4.9
Section 5.2	Matrix representation of linear transformations (possibly two lecture videos)
Section 6.1	Inner-product spaces
Section 1.6	Dot products, e.g., as a measure for angle and distance
Section 4.6	Projections, the Gram-Schmidt process, and QR factorization
Section 6.4	Least squares solutions
Section 6.4	Least squares continued, with examples
Section 6.3	Approximation of functions
Review Day	Last week of class, have one review Q/A lecture
	Exam 4, TBD During Finals Week Dec. 7—11, Sections 5.1-5.2, 4.6, 6.1, 6.3-6.4

Attendance Policy: Students are expected to fully participate in the course. Participation includes attendance for the remote scheduled sessions, completing homework in a timely manner, participating in class discussions, and getting help when needed.

- More broadly, the course follows the UNM handbook attendance policy https://handbook.unm.edu/d170/
- The handbook states that a student may be given a W or F for excessive **unexcused** absences.
- If you need to miss more than one of our remote schedule meetings, please contact the instructor. During this time of COVID-19, the instructor will be as flexible as possible.

Credit Hour Statement: This is a three credit-hour course. Students are expected to complete a minimum of six hours of out-of-class work (or homework, study, assignment completion, and class preparation) each week.

Academic Integrity: Each student is expected to maintain the highest standards of honesty and integrity in academic and professional matters. The University reserves the right to take disciplinary action, including dismissal, against any student who is found responsible for academic dishonesty or otherwise fails to meet the standards. Any student judged to have engaged in academic dishonesty in course work may receive a reduced or failing grade for the work in question and/or for the course.

Academic dishonesty includes, but is not limited to, dishonesty on quizzes, tests or assignments; claiming credit for work not done or done by others; and hindering the academic work of other students; misrepresenting academic or professional qualifications within or without the University; and nondisclosure or misrepresentation in filling out applications or other University records.

Accommodation Statement and Americans with Disabilities Act: In accordance with University Policy 2310 and the Americans with Disabilities Act (ADA), academic accommodations may be made for any student who notifies the instructor of the need for an accommodation. It is imperative that you take the initiative to bring such needs to the

instructor's attention, as I am not legally permitted to inquire. Students who may require assistance in emergency evacuations should contact the instructor as to the most appropriate procedures to follow. Contact Accessibility Resource Center at 277-3506 or arc.unm.edu for additional information.

If you need an accommodation based on how course requirements interact with the impact of a disability, you should contact me to arrange an appointment as soon as possible. At the appointment, we can discuss the course format and requirements, anticipate the need for adjustments and explore potential accommodations. I rely on the Disability Services Office for assistance in developing strategies and verifying accommodation needs. If you have not previously contacted them I encourage you to do so.

Title IX: In an effort to meet obligations under Title IX, UNM faculty, Teaching Assistants (TAs), and Graduate Assistants (GAs) are considered "responsible employees" by the Department of Education (see page 15, http://www2.ed.gov/about/offices/list/ocr/docs/qa-201404-title-ix.pdf). This designation requires that any report of gender discrimination which includes sexual harassment, sexual misconduct and sexual violence made to a faculty member, TA, or GA must be reported to the Title IX Coordinator at the Office of Equal Opportunity (http://oeo.unm.edu). For more information on the campus policy (2000, 2740) regarding sexual misconduct, see: https://policy.unm.edu/university-policies/2000/2740.html

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Citizenship and/or Immigration Status: All students are welcome in this class regardless of citizenship, residency, or immigration status. Your professor will respect your privacy if you choose to disclose your status. As for all students in the class, family emergency-related absences are normally excused with reasonable notice to the professor, as noted in the attendance guidelines above. UNM as an institution has made a core commitment to the success of all our students, including members of our undocumented community. The Administration's welcome is found on our website: http://undocumented.unm.edu/

Disclaimer: I reserve the right to make reasonable and necessary changes to the policies outlined in this syllabus. Whenever possible, the class will be notified in advance of such changes. An up-to-date copy of the syllabus can always be found on the course website. It is your responsibility to know and understand the policies discussed therein and to be up-to-date. If in doubt, please ask questions.