

Topics in Linear Algebra

MATH 471, Spring 2025

Lecture Section 39680R: 11-11:50am, MWF, KAP 140

Prerequisite: MATH 225 or MATH 235

Instructor: Calum Rickard

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Teaching Assistant: Sanat Mulay

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Office: [Math Center](#), KAP 263

Office Hours: Tue 3-4pm, W 3-4pm, Thu 1-2pm in the [Math Center](#), KAP 263

Textbook: *Matrix Mathematics: A Second Course in Linear Algebra*, by Stephen Ramon Garcia and Roger A. Horn, 2nd Edition, Required

Click here for a digital version of the text which is freely available by authenticating with your USC credentials.

Warmup Problems: During the first part of every lecture except Feb 19, Apr 9 & May 2 (see [Lecture Schedule](#) below), there will be a warmup problem which you will submit your answer to on [Gradescope](#) (ideally during class). To allow for flexibility, the warmup problem will be open on Gradescope until 11:59PM that same day with the problem itself accessible through the lecture recording & note posted quickly after class. The problem will simply be graded out of 1 point.

No late warmup problem submissions will be accepted. Your three lowest warmup problem grades will not be included when computing your final grade (see [Grading](#) below).

Homework: Will be assigned on [Gradescope](#) approximately every Friday (see [Lecture Schedule](#) below) and due on Gradescope by the following Friday at 11:59PM.

No late homework will be accepted. Your two lowest homework grades will not be included when computing your final grade (see [Grading](#) below).

Exams: Midterm 1: Friday, February 21, In Class Exam

Midterm 2: Friday, April 11, In Class Exam

Final Exam: Wednesday, May 7, 11am-1pm, KAP 140

All exams are closed book with no calculators allowed.

Grading: Warmup Problems (10%), Homework (20%),
Midterm 1 (20%), Midterm 2 (20%),
Final Exam (30%)

Each warmup problem and homework assignment is worth an equal amount towards its respective components of your final grade. Your three lowest warmup problem scores and your two lowest homework scores will not be included when computing your final grade.

Course announcements, assignments and grades will be posted on [Brightspace](#).

Course Communication: Email and/or direct Slack messages are always encouraged. You can also [click here to access the course Slack channel](#) where you may have questions answered by the instructor, teaching assistant and fellow students.

Topics Covered: The main topics, including where they appear in the text, are:

- Vector Spaces (Chapters 1-2)
- Rank-Nullity Theorem and Matrix Factorizations (Chapter 4, Chapter 7 & Chapter 15)
- Inner Products and Norms (Chapters 5-6 & Chapter 8)
- Eigenvalues and Diagonalization (Chapters 9-10)
- Jordan Form (Chapters 12-13)
- Spectral Theorem and Singular Value Decomposition (Chapter 14 & Chapters 16-17)
- Matrix Norms (Chapter 19)

Lecture Schedule (subject to change):

Section numbers are from the text which you can use as reading suggestions.

Date	Sections	Topic	Homework (HW)
Mon, Jan 13	1.1, 1.2	Vector Spaces	
Wed, Jan 15	1.3-1.5	Subspaces	
Fri, Jan 17	2.1, 2.2	Bases & Dimension	HW 1 assigned
Mon, Jan 20	No class	MLK Day	
Wed, Jan 22	2.4	Coordinate Vectors	
Fri, Jan 24	2.4	Linear Transformations	HW 1 due, HW 2 assigned
Mon, Jan 27	4.1	Rank-Nullity Theorem	

Wed, Jan 29	4.3	LU Factorization	
Fri, Jan 31	7.4	QR Factorization	HW 2 due, HW 3 assigned
Mon, Feb 3	15.4	Cholesky Factorization	
Wed, Feb 5	5.3	Inner Products	
Fri, Feb 7	5.4	Norms	HW 3 due, HW 4 assigned
Mon, Feb 10	5.5	Normed Vector Spaces	
Wed, Feb 12	6.1, 6.2	Orthonormal Vectors	
Fri, Feb 14	6.3	Gram-Schmidt	HW 4 due
Mon, Feb 17	No class	President's Day	
Wed, Feb 19	Sample Midterm 1	Midterm 1 review	
Fri, Feb 21		Midterm 1	
Mon, Feb 24	6.6	Adjoins	
Wed, Feb 26	8.1	Orthogonal Complements	
Fri, Feb 28	8.2	Minimum-Norm Solutions	HW 5 assigned
Mon, Mar 3	8.3	Orthogonal Projections	
Wed, Mar 5	8.4	Best Approximation	
Fri, Mar 7	9.1-9.3	Eigenvalues	HW 5 due, HW 6 assigned
Mon, Mar 10	9.4	Gershgorin Disks	
Wed, Mar 12	10.1	Characteristic Polynomial	
Fri, Mar 14	10.2, 10.3	Multiplicity	HW 6 due, HW 7 assigned
Mon, Mar 17	No class	Spring Recess	
Wed, Mar 19	No class	Spring Recess	
Fri, Mar 21	No class	Spring Recess	
Mon, Mar 24	10.4	Diagonalization	
Wed, Mar 26	10.5	Functional Calculus	
Fri, Mar 28	12.2	Jordan Blocks and Jordan Matrices	HW 7 due, HW 8 assigned
Mon, Mar 31	12.3, 12.4	Jordan Form	
Wed, Apr 2	12.4, 12.5	Jordan Form	
Fri, Apr 4	13.2	Convergent Matrices	HW 8 due
Mon, Apr 7	14.1	Normal Matrices	
Wed, Apr 9	Sample Midterm 2	Midterm 2 review	
Fri, Apr 11		Midterm 2	HW 9 assigned
Mon, Apr 14	14.2	Spectral Theorem	
Wed, Apr 16	14.2, 14.3, 14.6	Spectral Theorem & Applications	

Fri, Apr 18	16.1	Singular Value Decomposition	HW 9 due, HW 10 assigned
Mon, Apr 21	17.2	Spectral Norm	
Wed, Apr 23	17.3	Singular Values and Eigenvalues	
Fri, Apr 25	19.1, 19.2	Norms of Matrices	HW 10 due, HW 11 assigned
Mon, Apr 28	19.3	Spectral Radius	
Wed, Apr 30	19.4	Induced Matrix Norms	
Fri, May 2	Sample Final	Final Exam review	HW 11 due
Wed, May 7		<i>Final Exam</i>	

Policies and Statements:

Lecture Recordings: Lectures will be recorded with recordings posted in “USC Zoom” under “Course Tools” on the class Brightspace page.

Midterm absences: To protect academic integrity, all midterm exams must be taken in-person on the day the midterm is given in class. Due to the challenge of calibrating the difficulty of a midterm, there are no make-up midterms. If you anticipate missing a midterm, you must inform me with at least 24 hours notice (or in the case of an emergency, as soon as possible given the circumstances). Your other exams (including the final) will then be weighted to compensate.

Incomplete grade: If you miss the final for a documented emergency, you will receive a grade of IN. Consult the Office of Academic Records and Registrar for more information about an IN grade.

Students and disability accommodations: USC welcomes students with disabilities into all of the University’s educational programs. The Office of Student Accessibility Services (OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at osas.usc.edu. You may contact OSAS at (213) 740-0776 or via email at osasfront-desk@usc.edu.

Course Content Distribution and Student Recording Policies: USC has policies that prohibit recording and distribution of any synchronous and asynchronous course content outside of the learning environment.

Recording a university class without the express permission of the instructor and announcement to the class, or unless conducted pursuant to an Office of Student Accessibility Services (OSAS) accommodation. Recording can inhibit free discussion in the future, and thus infringe on the academic freedom of other students as well as the instructor. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Distribution or use of notes, recordings, exams, or other intellectual property, based on university classes or lectures without the express permission of the instructor for purposes other than individual or group study. This includes but is not limited to providing materials for distribution by services publishing course materials. This restriction on unauthorized use also applies to all information, which had been distributed to students or in any way had been displayed for use in relation to the class, whether obtained in class, via email, on the internet, or via any other media. Distributing course material without the instructor's permission will be presumed to be an intentional act to facilitate or enable academic dishonesty and is strictly prohibited. ([Living our Unifying Values: The USC Student Handbook](#), page 13).

Statement on Academic Integrity: The University of Southern California is a learning community committed to developing successful scholars and researchers dedicated to the pursuit of knowledge and the dissemination of ideas. Academic misconduct, which includes any act of dishonesty in the production or submission of academic work, compromises the integrity of the person who commits the act and can impugn the perceived integrity of the entire university community. It stands in opposition to the university's mission to research, educate, and contribute productively to our community and the world.

All students are expected to submit assignments that represent their own original work, and that have been prepared specifically for the course or section for which they have been submitted. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s).

Other violations of academic integrity include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), collusion, knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university. All incidences of academic misconduct will be reported to the Office of Academic Integrity and could result in outcomes such as failure on the assignment, failure in

the course, suspension, or even expulsion from the university.

For more information about academic integrity see the [student handbook](#) or the [Office of Academic Integrity's website](#), and university policies on [Research and Scholarship Misconduct](#).

Please ask your instructor if you are unsure what constitutes unauthorized assistance on an exam or assignment, or what information requires citation and/or attribution.

Support Resources:

Math Center:

The USC [Math Center](#) (KAP 263) is a place to go if you want help with your math classes. Please visit the [Math Center website](#) for more information.

Counseling and Mental Health:

Phone: (213) 740-9355 (available 24/7)

Website: <https://sites.usc.edu/counselingandmentalhealth/>

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

988 Suicide and Crisis Lifeline:

Phone: 988 for both calls and text messages (available 24/7)

Website: <https://988lifeline.org/>

The 988 Suicide and Crisis Lifeline (formerly known as the National Suicide Prevention Lifeline) provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week, across the United States. The Lifeline consists of a national network of over 200 local crisis centers, combining custom local care and resources with national standards and best practices. The new, shorter phone number makes it easier for people to remember and access mental health crisis services (though the previous 1 (800) 273-8255 number will continue to function indefinitely) and represents a continued commitment to those in crisis.

Relationship and Sexual Violence Prevention Services (RSVP):

Phone: (213) 740-9355 (24/7, press "0" after hours)

Website: <https://sites.usc.edu/clientsservices/>

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity, Equal Opportunity, and Title IX (EEO-TIX):

Phone: (213) 740-5086

Website: <https://eotix.usc.edu/>

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment:

Phone: (213) 740-2500

Website: <https://report.usc.edu/>

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title IX for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS):

Phone: (213) 740-0776

Website: <https://osas.usc.edu/>

OSAS ensures equal access for students with disabilities through providing academic accommodations and auxiliary aids in accordance with federal laws and university policy.

USC Campus Support and Intervention:

Phone: (213) 740-0411

Website: <https://campussupport.usc.edu/>

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC:

Phone: (213) 740-2101

Website: <https://diversity.usc.edu/>

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency:

Phone: UPC: (213) 740-4321, HSC: (323) 442-1000 (available 24/7)

Website: <https://www.usc.edu/emergency/>

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety:

Phone: UPC: (213) 740-6000, HSC: (323) 442-1200 (available 24/7)

Website: <https://dps.usc.edu/>

Non-emergency assistance or information.

Office of the Ombuds:

Phone: UPC: (213) 821-9556, HSC: (323) 442-0382

Website: <https://ombuds.usc.edu/>

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.

Occupational Therapy Faculty Practice:

Phone: (323) 442-2850

Email: otfp@med.usc.edu

Website: <https://chan.usc.edu/patient-care/faculty-practice>

Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.