USC Viterbi
School of Engineering

AME 525
Linear Algebra for Engineering Applications
Units: 4 (FALL 2024 MW 12:00-1:50)
Location: OHE 122

Instructor: P.K. Newton
Office: OHE 430D
Office Hours: MW 11-12 and by appointment via Zoom link
Contact Info: newton@usc.edu

Teaching Assistant: TBD
Office: TBD
Office Hours: TBD
Contact Info: TBD
IT Help: DEN Services

Catalogue Description
Solving systems of linear equations in engineering and science; eigenvalues and eigenvectors; singular values and singular vectors; linear transformations; regression and optimization; learning from data.

Course Description
The class is an introduction to matrix-based linear algebra appropriate for all engineering disciplines. The focus of the class is on solving linear inhomogeneous systems of equations of the form Ax=b in a vector space context, which arise when solving spring-mass vibrational systems, electrical networks, digital image compression, wave transmission and reflection problems, random walks on networks, numerical analysis for partial differential equations, curve fitting data, machine learning applications, and others. The course will teach the four fundamental subspaces associated with square and rectangular matrices A, along with useful methods of factorizing a matrix. Students will learn both calculational techniques for determining eigenvalues, eigenvectors, singular values, and singular vectors, as well as how they are used in determining matrix diagonalization, principal component analysis, and the search for optimal basis vectors. The course will cover matrix-based optimization techniques like linear regression and optimal curve fitting to data as well as various data reduction techniques and methods of learning from data. Emphasis will be placed on teaching practical techniques to solve linear algebra problems and to gain an appreciation for the ubiquitous and ever-increasing role that linear algebra plays in nearly all of engineering and data science disciplines.

Learning Objectives
Students will learn to apply fundamental linear algebra concepts and solve problems in engineering mathematics that will prepare them for further coursework along various tracks in the AME department as well as preparing them to solve problems for parts of the departmental screening exam. The course will also prepare those students who plan to work in industry after an M.S. degree.

Prerequisite(s): None

Co-Requisite(s): None
Concurrent Enrollment: None
Recommended Preparation: Multivariable calculus at the level of MATH 229.

Course Notes

Letter grade
The course will be run through the Distance Education Network (DEN) at Viterbi School of Engineering. Students can enroll either in the DEN section or the non-DEN section

Technological Proficiency and Hardware/Software Required

None

Required Readings and Supplementary Materials

Required book: Linear Algebra and Its Applications, Sixth Edition, D.C. Lay, S.R. Lay, J.J. McDonald, Pearson Education Limited, 2022.
https://www.pearson.com/en-us/subject-catalog/p/linear-algebra-and-its-applications/P200000006235/9780136880929
ISBN-13 978-1-292-35121-6

Optional Readings and Supplementary Materials

MITOPENCOURSEWARE: Linear Algebra (https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/)

Description of Assignments and How They Will Be Assessed

6 homework sets will be assigned bi-weekly starting in week 2. Assignments will closely follow the material presented in the book.

Grading Breakdown

Assessment Tool (assignments)	% of Grade
Weekly/Bi-weekly homework	35%
Midterm exam	30%
Final Exam	35%
TOTAL	100%

Grading Scale

The class will be graded on a curve based on total points earned according to the above weighting scale. Letter grades will not be assigned to individual assignments, but class averages and statistical breakdown will be announced for the midterm and final exams.

Assignment Submission Policy

Beginning week 2 and following every other week throughout the semester. All students will turn in homework via the Viterbi Brightspace portal. Students may use numeric or symbolic mathematics software packages in doing homework, but code listings must be given.

Course-Specific Policies

No late submissions allowed. All exams are in class and must be taken at the same time. There will be no re-scheduling of exams.

Academic Integrity

Unless otherwise noted, this course will follow the expectations for academic integrity as stated in the USC Student Handbook. The general USC guidelines on Academic Integrity and Course Content Distribution are provided in the subsequent "Statement on Academic Conduct and Support Systems" section.

For this class, students are allowed to work in groups for the homework, but each student must turn in their own homework not copying anyone else in their group.

Course Evaluations

Course evaluation occurs at the end of the semester university-wide.

Course Schedule

	Topics/Daily Activities	Readings/Preparation	Deliverables
Week 1	Overview of the semester and intro to Ax=b	Chapter 1	
Week 2	Solving linear systems	Chapter 1 HW 1 assigned	
Week 3	Matrices	Chapter 2	HW 1 due
Week 4	More matrices	Chapter 2 HW 2 assigned	Graded HW 1 returned
Week 5	Determinants	Chapter 3	HW 2 due
Week 6	Determinants and vector spaces	Chapter 3 HW 3 assigned	Graded HW 2 returned
Week 7	Vector spaces	Chapter 4	HW 3 due
Week 8	Midterm exam review **Midterm exam**	Chapter 4	Graded HW 3 returned
Week 9	Eigenvalues and eigenvectors	Chapter 5 HW 4 assigned	Midterm returned
Week 10	Eigenvalues of A; diagonalization; symmetric positive definite matrices; linear differential eqns and resonant frequencies; normal modes	Chapter 5	HW 4 due
Week 11	Orthogonality and least squares.	Chapter 6 HW 5 assigned	Graded HW 4 returned
Week 12	Orthogonality and least squares	Chapter 6	HW 5 due
Week 13	Singular value decomposition	Chapter 7 HW 6 assigned	Graded HW 5 returned
Week 14	Singular value decomposition	Chapter 7	HW 6 due
Week 15	Optimization, matrix games, linear programming, Markov chains.	Chapter 9,10	Graded HW 6 returned
FINAL	**Final exam**	Comprehensive	Refer to the final exam schedule in the USC *Schedule of Classes* at classes.usc.edu.

Statement on Academic Conduct and Support Systems

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, comprises 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.

Course Content Distribution and Synchronous Session Recordings 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 relationship to the class, whether obtained in class, via email, on the internet, or via any other media. (Living our Unifying Values: The USC Student Handbook, page 13).

Generative AI is not permitted: Since creating, analytical, and critical thinking skills are part of the learning outcomes of this course, all assignments should be prepared by the student working individually or in groups as described on each assignment. Students may not have another person or entity complete any portion of the assignment. Developing strong competencies in these areas will prepare you for a competitive workplace. Therefore, using AI-generated tools is prohibited in this course, will be identified as plagiarism, and will be reported to the Office of Academic Integrity.

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 osasfrontdesk@usc.edu.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
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 - 988 for both calls and text messages – 24/7 on call
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 is comprised 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) - (213) 740-9355(WELL) – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender- and power-based harm (including sexual assault, intimate partner violence, and stalking).

Office for Equity, Equal Opportunity, and Title IX (EEO-TIX) - (213) 740-5086
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 - (213) 740-5086 or (213) 821-8298
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office for Equity, Equal Opportunity, and Title for appropriate investigation, supportive measures, and response.

The Office of Student Accessibility Services (OSAS) - (213) 740-0776
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 - (213) 740-0411
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity, Equity and Inclusion - (213) 740-2101
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 - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
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 - UPC: (213) 740-6000, HSC: (323) 442-1200 – 24/7 on call
Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)
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 - (323) 442-2850 or otfp@med.usc.edu
Confidential Lifestyle Redesign services for USC students to support health promoting habits and routines that enhance quality of life and academic performance.