Course Syllabus

Linear Algebra MA 232

Department of Mathematical Sciences

School of Engineering and Science

Fall 2023

Instructor: Andrey Nikolaev

Canvas Course Address (this shell): **https://sit.instructure.com/courses/69250 (https://sit.instructure.com/courses/69250)**

Course Schedule:

- Section A: Tuesday, Thursday 12:30 PM - 1:45 PM (GN 204)
- Section B: Tuesday, Thursday 3:30 PM - 4:45 PM (EAS 222)

Contact Info: **anikolae@stevens.edu (mailto:anikolae@stevens.edu) Please use this email, not the Canvas message feature.**

Office Hours: Mondays 2:30pm-3:30pm, Tuesdays 5:30pm-6:30pm (or by appointment), in NB 226 and **https://stevens.zoom.us/j/9251603776 (https://stevens.zoom.us/j/9251603776)**

Prerequisite(s): MA 125

Corequisite(s): None

Cross-listed with: None

COURSE DESCRIPTION

Linear algebra is central to many areas of mathematics and is used in a broad range of fields of science and engineering. This course builds on MA 125 (Vectors and Matrices) to introduce further

ideas and methods of linear algebra, such as Gaussian elimination to solve systems of linear equations; LU-decomposition; independent and dependent vectors; vector spaces, bases, and dimension; the fundamental theorems of linear algebra; norms and inner products in vector spaces; determinants, eigenvalues, and eigenvectors of matrices; symmetric, orthogonal matrices; matrix representations of linear transformations and orthogonal projections; the method of least-squares; singular value decomposition; and select applied topics.

STUDENT LEARNING OUTCOMES

- Perform algebraic operations, such as addition, multiplication and inversion of matrices with real and complex entries.
- Apply the method of Gauss elimination to solve systems of linear equations, to find LU and LDU decompositions, and to calculate the four fundamental spaces of a matrix.
- Find orthogonal projections of vectors onto subspaces and solve optimization problems using the least square approximation method.
- Identify orthonormal bases and use the Gram-Schmidt method to produce them.
- Solve systems of equations using Cramer's rule, find determinant of a matrix using the cofactor expansion.
- Calculate the eigenvalues, eigenvectors of a matrix and use them to analyze symmetric and positive-definite matrices.
- Compute the singular value decomposition of a matrix.
- Recognize linear transformations, represent linear transformations by matrices, perform change of basis.

COURSE FORMAT AND STRUCTURE

This course is on-campus. To access the course, please visit **stevens.edu/canvas (http://stevens.edu/canvas)** . For more information about course access or support, contact the Technology Resource and Assistance Center (TRAC) by calling 201-216-5500.

Course Logistics

- Classes will be conducted in person as scheduled and, unless there are technical issues, simultaneously cast in Zoom.
- Written Homework assignments are due on Friday by 5:00 pm ET. Submission will be organized via Gradescope.

- Exams will be given during weeks 5, 9, 13 of the course **(tentatively)**, and during the final exam period.
- Course requirements must be completed and posted or submitted on or before specified due date and delivery time deadline. Due dates and delivery time deadlines are defined as Eastern Time (as used in Hoboken, NJ). Please note, students living in distance time zones or overseas must comply with this course time and time and due date deadline policy. Avoid any inclination to procrastinate. To encourage you to stay on schedule, due dates have been established for each assignment; 10% of the total points will be deducted for assignments received at most 2 days late; assignments received more than 2 days late will receive 0 points.
- All solutions must show supporting work. Failure of doing so results in 0 points.

Instructor's Hours

I will answer email inquiries within 3 business days, most of the time the same business day. In particular, note that emails after 7pm will likely be seen only the following business day.

Office Hours

Virtual Office Hours are a synchronous session (through Zoom or in person) to discuss questions related to weekly readings and/or assignments, or any other course matters.

- Mondays 2:30pm-3:30pm, Tuesdays 5:30pm-6:30pm in NB 226 and at **https://stevens.zoom.us/j/9251603776 (https://stevens.zoom.us/j/9251603776)** ,
- Or, by appointment: if you want to meet outside of my regularly schedule Office Hours, please let me know. Typically half a day notice will suffice.

Online Etiquette Guidelines

Your instructor and fellow students wish to foster a safe online learning environment. No matter how different or controversial they may be perceived, all opinions and experiences must be respected in the tolerant spirit of academic discourse. You are encouraged to comment, question, or critique an idea, but you cannot attack an individual. Our differences, some of which are outlined in the University's inclusion statement below, will add richness to this learning experience. Please consider that sarcasm and humor can be misconstrued in online interactions and generate unintended disruptions. Working as a community of learners, we can build a polite and respectful course ambiance. Please read the Netiquette rules for this course:

- Do not dominate any discussion. Allow other students to join in the discussion.
- Do not use offensive language. Present ideas appropriately.
- Be cautious in using Internet language. For example, do not capitalize all letters since this suggests shouting.
- Avoid using vernacular and/or slang language as it could lead to misinterpretation.

- Keep an "open-mind" and be willing to express even your minority opinion.
- Think and edit before you push the "Send" button.
- Do not hesitate to ask for feedback.

TENTATIVE COURSE SCHEDULE

Note: the schedule below is **tentative** in the sense that the same material will likely end up cut into weeks differently. Please refer to individual modules and announcements for factual information. Further, note that the term *Week* in the table below refers to **abstract** weeks rather than literal calendar weeks. Namely, **"Week N" should be understood as "Classes 2N-1 and 2N"**.

Week	Topic(s)	Readings	Assignment issued
Week 1	MA-125 Review: Linear equations and elimination, reduced row-echelon form. MA-125 Review: Matrices and matrix operations, matrix inversion	Required: 1.1-1.3, 2.1-2.5	HW1
Week 2	LU- and LDU-decomposition. Transpose, symmetric matrices, LDL^T-decomposition.	Required: 2.6-2.7	HW2
Week 3	Subspaces, nullspace, column space. Complete solution to Ax=b.	Required: 3.1-3.3	HW3
Week 4	Independence, basis, dimension, counting theorem. Orthogonality of four fundamental subspaces	Required: 3.4-3.5, 4.1	HW4
Week 5	Exam 1. Projections, Least squares approximation	Required: 4.2, 4.3	Exam 1
Week 6	Orthonormal basis, Gram-Schmidt process.	Required: 4.4, 5.1	HW5

	Determinants.		
Week 7	Permutations and cofactors. Cramer's rule; Determinant as volume.	Required: 5.2-5.3	HW6
Week 8	Intro to Eigenvalues. Diagonalization	Required: 6.1-6.2	HW7
Week 9	Exam 2. Application of diagonalization to differential equations. Symmetric matrices.	Required: 6.3-6.4	Exam 2
Week 10	Positive definite matrices. Image processing with linear algebra.	Required: 6.5, 7.1	HW8
Week 11	Singular Value Decomposition. Linear transformations.	Required: 7.2, 8.1	HW 9
Week 12	Matrix of a linear transformation. Notion of Jordan normal form of a matrix. Matrix similarity.	Required: 8.2-8.3	HW10
Week 13	Exam 3. Applied topics.	Required: select topics in Ch. 9, 10, 11	

Week 14	Applied topics.	Required: select topics in Ch. 9, 10, 11	

Applied topics may include material of Chapters 9–11 of textbook or material from other sources, for example: complex matrices and fast Fourier transform (9.1–9.3), network flows (10.1), Markov processes (10.3), linear programming (10.4); computer graphics (10.5); computation with sparse matrices; practice in numerical linear algebra (programming); challenges of numerical linear algebra (11.1–11.2); iterative methods (11.3); linear error correcting codes.

COURSE MATERIALS

Textbook(s): Gilbert Strang - Introduction to LINEAR ALGEBRA (5th edition).

Other Readings: S. Axler - Linear Algebra Done Right (3rd edition).

See also **this page (https://sit.instructure.com/courses/69250/pages/textbook-and-other-materials)** for more suggestions of resources.

COURSE REQUIREMENTS

- **Written Homework:** There will be 9 to 11 (likely, 10) written Homework assignments.
- **Exams:** There will be 3 midterm exams and a final exam. The 3 midterm exams will be scheduled during Tuesday or Thursday lecture periods of Weeks 5, 9, 13 (**tentatively**). The Final Exam will be scheduled during the final exam period. All these exams will contain a combination of multiple choice and long answer questions. Midterm Exams will be non-cumulative (only cover material not covered on previous Midterm Exams); Final Exam will be cumulative (cover entire course).
- **Participation:** During some of the lectures students will work in small groups to solve problem(s) and conference as a class.

TECHNOLOGY REQUIREMENTS

Baseline technical skills necessary for online courses

- Basic computer and web-browsing skills
- Navigating Canvas

Technology skills necessary for this specific course

- Live web conferencing using Zoom

Required Equipment

- Computer: current Mac (OS X) or PC (Windows 7+) with high-speed internet connection
- Webcam: built-in or external webcam, fully installed
- Microphone: built-in laptop or tablet mic or external microphone

Required Software

- Scanning app. Note that Gradescope now has an app that includes scan feature.
- PDF Viewer

GRADING PROCEDURES

Grades will be based on:

Homework (9 to 11)	39%
Midterm Exams 1-3 (3)	39%
Final Exam	22%

See **Grading Scheme and Letter Grade Scale (https://sit.instructure.com/courses/69250/pages/grading-scheme-and-letter-grade-scale?wrap=1)** for details how percentage is converted to a letter grade.

Late Policy

10% of the total points will be deducted for written homework received up to 2 days late; assignments received more than 2 days late will receive 0 points. Exams, if absolutely necessary, will have a single make up day. Not attending an exam or the corresponding make-up results to 0 points.

Academic Integrity

Generative AI Technologies

You may use AI programs e.g. ChatGPT to help generate ideas and brainstorm. However, you should note that the material generated by these programs may be inaccurate, incomplete, or

otherwise problematic. Beware that use may also stifle your own independent thinking and creativity. Also, careful: ChatGPT is **really bad** at linear algebra.

You may not submit any work generated by an AI program as your own. If you include material generated by an AI program, it should be credited explicitly.

Any plagiarism or other form of cheating will be dealt with under relevant Stevens policies.

Undergraduate Honor System

Enrollment into the undergraduate class of Stevens Institute of Technology signifies a student's commitment to the Honor System. Accordingly, the provisions of the Stevens Honor System apply to all undergraduate students in coursework and Honor Board proceedings. It is the responsibility of each student to become acquainted with and to uphold the ideals set forth in the Honor System Constitution. More information about the Honor System including the constitution, bylaws, investigative procedures, and the penalty matrix can be found online at **http://web.stevens.edu/honor/ (http://web.stevens.edu/honor/)**

The following pledge shall be written in full and signed by every student on all submitted work (including, but not limited to, homework, projects, lab reports, code, quizzes and exams) that is assigned by the course instructor. No work shall be graded unless the pledge is written in full and signed.

"I pledge my honor that I have abided by the Stevens Honor System."

Reporting Honor System Violations

Students who believe a violation of the Honor System has been committed should report it within ten business days of the suspected violation. Students have the option to remain anonymous and can report violations online at **www.stevens.edu/honor (http://www.stevens.edu/honor)** .

EXAM CONDITIONS

The following procedures apply to quizzes and exams for this course. As the instructor, I reserve the right to modify any conditions set forth below by printing revised Exam Conditions on the quiz or exam.

1. Students may use the following materials during quizzes and/or exams. Any materials that are not mentioned in the list below are not permitted.

Material	Permitted?	
	Yes	No

Handwritten Notes Conditions: **1 one-sided handwritten letter-size sheet only**	X	
Typed Notes		X
Textbooks or any other books		X
Readings		X

2. Students are not allowed to work with or talk to other students during quizzes and/or exams. Students are not allowed to consult any other resources, digital or otherwise, other than self-prepared "cheat-sheet" (see the above table) during the exams.

LEARNING ACCOMMODATIONS

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. The Office of Disability Services (ODS) works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, psychiatric disorders, and other such disabilities in order to help students achieve their academic and personal potential. They facilitate equal access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to encourage independence and self-advocacy with support from the ODS staff. The ODS staff will facilitate the provision of accommodations on a case-by-case basis.

For more information about Disability Services and the process to receive accommodations, visit **https://www.stevens.edu/office-disability-services (https://www.stevens.edu/office-disability-services)** . If you have any questions please contact: Phillip Gehman, the Director of Disability Services Coordinator at Stevens Institute of Technology at **pgehman@stevens.edu (mailto:pgehman@stevens.edu)** or by phone 201-216-3748.

Disability Services Confidentiality Policy

Student Disability Files are kept separate from academic files and are stored in a secure location within the Office of Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by

Stevens Disability Services. According to this act, prior written consent by the student is required before our Disability Services office may release disability documentation or records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

INCLUSIVITY

Name and Pronoun Usage

As this course includes group work and class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect. This includes the ability for all students to have their chosen gender pronoun(s) and chosen name affirmed. If the class roster does not align with your name and/or pronouns, please inform the instructor of the necessary changes.

Inclusion Statement

Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in academic discourse and innovation. In this class, the perspective of people of all races, ethnicities, gender expressions and gender identities, religions, sexual orientations, disabilities, socioeconomic backgrounds, and nationalities will be respected and viewed as a resource and benefit throughout the semester. Suggestions to further diversify class materials and assignments are encouraged. If any course meetings conflict with your religious events, please do not hesitate to reach out to your instructor to make alternative arrangements.

You are expected to treat your instructor and all other participants in the course with courtesy and respect. Disrespectful conduct and harassing statements will not be tolerated and may result in disciplinary actions.

MENTAL HEALTH RESOURCES

Part of being successful in the classroom involves a focus on your whole self, including your mental health. While you are at Stevens, there are many resources to promote and support mental health. The Office of Counseling and Psychological Services (CAPS) offers free and confidential services to all enrolled students who are struggling to cope with personal issues (e.g., difficulty adjusting to college or trouble managing stress) or psychological difficulties (e.g., anxiety and depression). Appointments can be made by phone (201-216-5177).

EMERGENCY INFORMATION

In the event of an urgent or emergent concern about the safety of yourself or someone else in the Stevens community, please immediately call the Stevens Campus Police at 201-216-5105 or on their emergency line at 201-216-3911. These phone lines are staffed 24/7, year round. For students who do not reside near the campus and require emergency support, please contact your local emergency response providers at 911 or via your local police precinct. Other 24/7 national resources for students dealing with mental health crises include the National Suicide Prevention Lifeline (1-800-273-8255) and the Crisis Text Line (text “Home” to 741-741). If you are concerned about the wellbeing of another Stevens student, and the matter is *not* urgent or time sensitive, please email the CARE Team at **care@stevens.edu (mailto:care@stevens.edu)** . A member of the CARE Team will respond to your concern as soon as possible.