MATH 200C : Linear Algebra

Course Description/Syllabus
Spring Term 2026

***Course Title*:** **Linear Algebra**

***Catalog Description*:** Matrices and systems of linear equations, the Euclidean space of three dimensions and other real vector spaces, independence and dimensions, scalar products and orthogonality, linear transformations and matrix representations, eigenvalues and similarity, determinants, the inverse of a matrix and Cramer's rule..

Additional Description: Linear Algebra is the first mathematics course that goes beyond the basic tools of mathematics: arithmetic, algebra, geometry, trigonometry, and calculus. In addition to studying many important mathematical results and techniques, you will give much greater attention to learning definitions carefully, stating theorems precisely, and understanding the proofs of many theorems. The material covered in linear algebra plays an essential role in all of the rest of higher mathematics and related areas of computer science, statistics, physics, and other natural and social sciences.

Linear algebra is the mathematical backbone for many Nobel Prize-winning discoveries in Physics and Economic Sciences. These prizes often recognize the application of matrices, vector spaces, and linear algorithms to analyze complex systems, predict economic behaviors, and model physical realities. Google became a multi-billion dollar enterprise because of a linear algebra algorithm

We can often model real world situations at least approximately by linear relations. Whether they take place in the physical, biological, chemical, economic, political or social sphere, studying these phenomena frequently leads to examining collections of linear equations.

We start with systems of linear equations. There are a number of natural questions: When does a solution exist? Can there be multiple solutions? How do you find them? What conditions guarantee that there is a unique solution? Is there a geometric interpretation?

We will develop the theoretical structures that lead to answering such questions. Our approach will balance theory, computation and applications while helping you improve your intellectual sophistication, understanding proofs, and writing mathematical arguments.

I hope you find the course to be an intellectually stimulating and enjoyable experience!

Course Website: ***s26.middlebury.edu/MATH0200C***

Prerequisites: A good background is a year's study of calculus in secondary school or completion of MATH 121:Calculus I at Middlebury. Very little in the way of technical knowledge of differentiation and integration techniques will be required. In fact, students with no calculus background but four years of secondary school mathematics can excel in Linear Algebra. What is needed is curiosity, a thirst for understanding, good organizational skills, and an appreciation for the importance of clarity and precision in language.

Learning Objectives:

- Understand basic linear algebra techniques
- Gain the skills to perform computations involving vectors, matrices, and systems of linear equations
- Appreciate applications of linear algebra to economics, biology, computer sciences, physics, engineering, the social sciences, etc
- Strengthen your desire for further study of mathematics
- Improve your ability to write a logical and coherent mathematical proof

***Instructor*:** Michael Olinick, Office: 202 Warner, Phone: 443-5559. Home telephone: 388-4290; email: *molinick@middlebury.edu*. My usual office hours will be Monday, Wednesday and Friday from 8:30 to 9:30 and 10:40 to 11 AM, and 12:05 to 1 PM on Monday and Wednesday. I would be happy to make an appointment to see you at other mutually convenient times.

***Meeting Times*:** MATH 200C: MWF 11:15AM – 12:05 PM (Warner 100)

***Prerequisites*:** Calculus I (MATH 121) or permission.

***Textbook*:** David Lay, Steven Lay and Judi McDonald, *Linear Algebra And Its Applications,* Sixth Edition: Pearson, 2020 update; ISBN-13: 9780135851258. Your daily assignments will include a few pages of reading in the text. Be certain to read the book carefully (with pencil and paper close by!) and to complete the relevant reading **before** coming to class and before embarking on the homework problems.

Computer Algebra Systems: Mathematically oriented software such as *MATLAB*, *Maple*, and *Mathematica* give you an opportunity to investigate the ideas of linear algebra in ways not available to previous generations of students. Relatively simple commands can direct a computer to carry out complex calculations rapidly and without error. More importantly, you can create and carry out experiments to develop and test your own conjectures. The very powerful graphics capabilities of these applications provide you with strong tools to deepen your understanding of Linear Algebra . *MATLAB* is an especially powerful computational and visualization tool which is used extensively in scientific research and engineering applications. Intermediate and advanced required and elective courses in Middlebury's Applied Mathematics Track adopt *MATLAB* as the de facto programming tool. There will be a required introductory *MATLAB* workshop late in the first week of the term; you will be able to choose either a Thursday evening or Friday afternoon session.

***Requirements*:** There will be three midterm examinations and a final examination in addition to required daily homework assignments and an extended independent team project. The midterm examinations will be given in the evening to eliminate time pressure. Tentative dates for these tests are:

Wednesday, March 4
Wednesday, April 8
Wednesday, May 6

Final Exam: The registrar's office has **tentatively** set the date and time of our final exam:

Thursday, May 14, 9 AM – Noon

Course Grades: Each of the midterm exams will be worth approximately 20%, the final about 30%, projects roughly 10%. I will make adjustments with later work counting more heavily if students show improvement over earlier results.

The mathematics department regards a C grade as an indication of satisfactory *understanding* of the course material, a B as good/very good understanding and an A as an excellent/superior grasp of the material. Typically, but not always, these tend to correlate with averages in the 70's, 80's and 90's, respectively. I do strive to issue course grades keeping in mind the hundreds of students I have had in calculus classes over the years.

Accommodations Students who have Letters of Accommodation in this class are encouraged to contact me as early in the semester as possible to ensure that such accommodations are implemented in a timely fashion. For those without Letters of Accommodation, assistance is available to eligible students through the Disability Resource Center (DRC). Please contact ADA Coordinators Jodi Litchfield and Peter Ploegman of the DRC at ada@middlebury.edu for more information. All discussions will remain confidential.

Homework: Mathematics is not a spectator sport! You must be a participant. The only effective way to learn mathematics is to do mathematics. In your case, this includes working out many multivariable calculus problems.

There will be daily written homework assignments which you will be expected to complete and submit. They will be corrected and assigned a numerical score, but I view these assignments primarily as **learning** rather than testing experiences. I will occasionally assign some challenging problems which everyone may not be able to solve. You should, however, make an honest attempt at every problem.

Each homework assignment will probably take you between 2 and 3 hours to complete; this includes the reading and problem solving. If you keep pace with the course by spending an hour or so each day on it, then you will be quite successful. If you wait until the end of the week and then try to spend one 6 hour block of time on the material, then experience shows you face disaster!

Homework grades for this term are Bailey Parent (jparent@middlebury.edu) and Misha Trupo (mtrupo@middlebury.edu)

***Honor Code**:* The examinations are to be taken without any information of any kind about the exam or its questions from any source but me. (I will give you a clear idea about what to expect on each exam.) Exams will be closed book, closed notes, and taken without calculators. Any departure from these policies would be a violation of the Honor Code and thus would be subject to a judicial review.

Homework is a different story: Calculators and MATLAB are ok for checking work and for doing tedious calculations. I encourage you to discuss problems with other students. But when you do that, you must give credit for another's contributions by naming the person on your solution. Writing up each problem solution must be done by you only. Failure to follow these requirements is a violation of the Honor system. The principle here is simple: consultation and collaboration are welcome, but you must explicitly acknowledge any and all intellectual content that is not solely yours. This rule should apply in all of your college work.

Help: Please see me immediately if you have any difficulties with this course. There are ample resources on campus for assistance, including the Center for Teaching, Learning and Research in the Davis Family Library and the Q-Center ("Armstrong Quantitative Center") in BiHall. The College will be assigning tutors to work with students in our course; they will schedule drop-in help sessions several nights a week. Stay tuned for more details.

One of the essential characteristics of college life that distinguishes it from secondary school is the increased responsibility placed on *you* for your own education. **Most of what you will learn will not be told to you by a teacher inside a classroom**.

Even if our model of you were an empty vessel waiting passively to be filled with information and wisdom, there would not be time enough in our daily meetings to present and explain it all.

We see you, more appropriately, as an *active* learner ready to confront aggressively the often times subtle and difficult ideas our courses contain. You will need to listen and to read carefully, to master concepts by wrestling with numerous examples and problems, and to ask thoughtful questions.

As you progress through the undergraduate mathematics curriculum, emphasis changes from mastering techniques to solve problems to learning the theory that underlies the particular subject you are studying. *Linear Algebr* is a transitional course. You will do plenty of calculations, find many matrix products and inverses, and deal with a full quota of vector operations. You will also find more of your effort directed toward understanding definitions, statements of theorems and their proofs. You will even be expected to come up with some short proofs of your own.

One of my goals for you this term is to develop your skills in *reading* mathematical expositions. I will expect that you will have read (perhaps more than once!) in advance the sections of the text relevant to the topic we will be exploring in class that day. I will not normally present a lecture which substitutes for reading the text. I will more likely use time in class to give a broader overview or alternative proofs or interesting applications and extensions of the material or previews of the next section.

Policy on Generative AI: Please see our Policy on AI Usage Any use of generative AI tools will be treated as a violation of Middlebury's Honor Code.

MATH 200: Spring 2026
Tentative Course Outline
(Times are approximate)

Linear Equations in Linear Algebra (~ 3 weeks)

Systems of Linear Equations
Row Reduction and Echelon Forms
Vector Equations
The Matrix Equation **Ax = b**
Solution Sets of Linear Systems
Applications of Linear Systems
Linear Independence
Introduction to Linear Transformations
The Matrix of a Linear Transformation
Linear Models in Business, Science, and Engineering

Matrix Algebra (~ 3 weeks)

Matrix Operations
The Inverse of a Matrix
Characterizations of Invertible Matrices
Partitioned Matrices
Matrix Factorizations
The Leontief Input—Output Model
Applications to Computer Graphics
Subspaces of R^n
Dimension and Rank

Vector Spaces (~3 weeks)

Vector Spaces and Subspaces
Null Spaces, Column Spaces, and Linear Transformations
Linearly Independent Sets; Bases
Coordinate Systems
The Dimension of a Vector Space
Rank; Change of Basis
Applications to Markov Chains

Eigenvalues and Eigenvectors (1 week)

Eigenvectors and Eigenvalues
The Characteristic Equation
Diagonalization
Eigenvectors and Linear Transformations

Determinants

Introduction to Determinants
Properties of Determinants

Finite-State Markov Chains (1 week)

Google and Markov Chains
The Steady-State Vector and Google's PageRank

Orthogonality and Least Squares (1 week)

Inner Product, Length, and Orthogonality
Orthogonal Sets
Orthogonal Projections
The Gram—Schmidt Process
Least-Squares Problems