# MATH-218: LINEAR ALGEBRA

**Effective Term**
Fall 2026

**BOT Approval Date**
05/15/2025

**Discipline**
MATH - Mathematics

**Course Number**
218

**Course Title**
Linear Algebra

**Short Title**
Linear Algebra

**Credit Status (CB 04)**
D - Credit - Degree applicable

## Units

**Lecture Units**
3.00

**Total Units**
3.00

## Hours

**Lecture Contact Hours**
48-54

**Out of Class Hours Lecture**
96-108

**Total Contact Hours**
48 - 54

**Total Out of Class Hours**
96 - 108

**Total Student Learning Hours**
144 - 162

**Distance Education**
Yes

## Distance Education

**Distance Education Type**
Both Fully Online and Hybrid Online

**Fully Online Delivery Requirements:**
**a. Students must be notified via the college schedule of classes and the syllabus for the class if proctored tests are required for this course**
**b. Any planned face-to-face meetings, such as an orientation or study session, must be optional**

**c. The MSJC curriculum committee requires the use of accessible, asynchronous discussion as a component of every fully online course**

**Are you using publisher content?**

No

**Regular Substantive Interaction**

Instructor-to-student, student-to-student, and student-to-content contact shall be distributed in a manner that will ensure regular substantive interaction (RSI) is maintained not only weekly but also for the duration of the course. Instructor interactions should be equivalent in time, quality and consistency to the engagement students would receive in a face-to-face course—for example, through announcements, discussion participation, personalized feedback, video messages, or other instructional communications. Instructors are expected to be responsive to student inquiries within a 24-72 hour time frame excluding holidays. RSI will be maintained through a variety of methods: • Orientation - Students must be oriented to the online and face-to-face portions at the start of the course. • Announcements - Announcements using the course management system must be posted at least weekly to keep students current on course events, due dates, materials, etc. • Discussion Forums - Content-related discussion forums within the designated CMS will include appropriate instructor participation and will be initiated and maintained, with timely feedback provided. Instructors are required to monitor the discussions and related activities to provide guidance and direction. Open-ended discussion boards may be used to further learning and interaction. • MSJC Communication – Instructor will use MSJC-administered communication tools (such as email or the designated CMS communication tools) to regularly communicate with and provide ease of access to students. • Timely Feedback - Timely feedback on student work will be provided by the instructor, which may include comments and/or rubrics, within the Grades area of the designated CMS. • Scheduled Meetings – Hybrid and synchronous courses will meet at regularly scheduled times. ADA Compliance - All course interactions and content must be designed with accessibility in mind and meet ADA requirements.

**Catalog Description**

This course covers matrix algebra, matrices and linear equations, determinants, vector spaces, linear transformations, eigenvalues, eigenvectors, orthogonal matrices, and symmetric matrices. It also examines related topics and applications.

## Requisites

**Prerequisite(s)**

| Prerequisite(s) (must be taken before) |
|---|
| MATH-C2210 (with a grade of C or better). |

## Codes

**TOP Code (CB 03)**

1701.00 - Mathematics, General

**CIP Code**

27.0101 - Mathematics, General.

**Repeatability Code**

No

**Grading Option**

Letter grade OR P/NP

**Minimum Qualifications**

| Minimum Qualifications | And/Or |
|---|---|
| Mathematics (Masters Required) | End |

## GE Information

**Check GE Types Requested**

AA/AS G - Math Competency

## Cal-GETC Areas

**Approved Cal-GETC Area**
AREA-2

## Learning Objectives

**Learning Objectives**

| Learning Objective |
| --- |
| 1. Produce solutions of systems of equations using various methods appropriate to lower division linear algebra. |
| 2. Solve problems in linear algebra using bases and orthonormal bases. |
| 3. Deduce the dimension of spaces such as those associated with matrices and linear transformations. |
| 4. Determine the eigenvalues and eigenvectors of matrices and use them in applications. |
| 5. Produce proofs of basic results in linear algebra using appropriate proof-writing techniques such as linear independence of vectors; properties of subspaces; linearity, injectivity and surjectivity of functions; and properties of eigenvectors and eigenvalues. |
| 6. Discuss the multicultural origins of and the diverse set of mathematicians who contributed to linear algebra and other fields of mathematics. |

## Learning Outcome Information

**Course Learning Outcomes**

| Learning Outcome |
| --- |
| 1. Students will determine whether a span in 3-space is a line, plane, or the whole 3-space. |
| 2. Students will formulate a matrix A such that the function induced by A is equal to a given linear transformation T. |
| 3. Students will find bases for the eigenspaces of a given matrix A. |

## Content

**Course Lecture Content**

1. Techniques for solving systems of linear equations including Gaussian and Gauss-Jordan elimination and inverse matrices.
2. Matrix algebra, invertibility, and the transpose.
3. Relationship between coefficient matrix invertibility and solutions to a system of linear equations and the inverse matrices.
4. Special matrices: diagonal, triangular, and symmetric.
5. Determinants and their properties.
6. Vector algebra for #$^{n}$.
7. Real vector space and subspaces.
8. Linear independence and dependence.
9. Basis and dimension of a vector space.
10. Matrix-generated spaces: row space, column space, null space, rank, nullity.
11. Change of basis.
12. Linear transformations, kernel and range, and inverse linear transformations.
13. Matrices of general linear transformations.
14. Eigenvalues, eigenvectors, eigenspace.
15. Diagonalization including orthogonal diagonalization of symmetric matrices.
16. Inner products on a real vector space.
17. Dot product, norm of a vector, angle between vectors, orthogonality of two vectors in #$^{n}$.
18. Angle and orthogonality in inner product spaces.
19. Orthogonal and orthonormal bases: Gram-Schmidt process.
20. The multicultural origins of and the diverse set of mathematicians who contributed to linear algebra and other fields of mathematics.

## Methods of Instruction

**Method**

Discussion

**Integration**

Diverse groups of students will discuss how to apply concepts and techniques in such areas of linear algebra as matrix and vector operations, analyzing vector spaces, and synthesizing linear transformations. The instructor will encourage student interaction to discuss the multicultural origins of and the diverse set of mathematicians who contributed to linear algebra and other fields of mathematics. The instructor will lead discussions of prior positive and negative experiences with mathematics and strategies to success in mathematics.

**DE Adaptations for MOI**

Group discussions will be completed using online discussions delivered through the CMS. Synchronous group interactions will take place via accessible video conferencing tools accessed via the CMS that allow for online document sharing. The instructor will ensure that accessibility requirements are met.

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**Method**

Homework

**Integration**

Homework assignments will allow students to practice applying linear algebraic concepts and techniques to various problems, including solving systems of linear equations using Gaussian elimination, computing the eigenvalues and eigenvectors of a matrix, and determining if a set of vectors is linearly independent.

**DE Adaptations for MOI**

Students will access homework assignments via the CMS. They will complete homework problems with paper and pencil, then submit their work through the CMS by uploading a photo or scan of their work, by submitting solutions typed up using a rich text editor or LaTeX, or via a mathematics assessment system such as MyOpenMath, while ensuring that accessibility requirements are met. The instructor will review their work and provide feedback through the CMS within one week after the assignment due date.

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**Method**

Lecture

**Integration**

The instructor will lecture to present linear algebraic terminology, explain the theory of linear algebra, and illustrate how to solve problems such as finding the basis of a vector space, computing the inverse of a nonsingular matrix, and compute the determinant of a square matrix. During lecture, the instructor will encourage student feedback and interaction with the instructor.

**DE Adaptations for MOI**

Lecture content will be communicated through pre-recorded videos, live teleconferencing, and/or text and images delivered through the CMS. The instructor will ensure that accessibility requirements are met.

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**Method**

Observation and Demonstration

**Integration**

Students will observe the instructor demonstrate techniques to evaluate answers to linear algebra problems, such as how to calculate the inner product of two vectors, how to multiply two matrices, and how to find the standard matrix of a linear transformation. Also, technology based demonstrations will use software to visualize 3-D operations such as projections and rotations in linear algebra.

**DE Adaptations for MOI**

Students will observe the demonstrations through live teleconferencing and/or pre-recorded videos shared through the CMS. The instructor will ensure that accessibility requirement are met.

**Method**

Activity

**Integration**

Students will work in groups of 3 to 4 people in class to practice linear algebra problems, such as writing proofs of the properties of vector spaces, determining if a set of vectors is linearly independent, and solving systems of linear equations using elementary row operations.

**DE Adaptations for MOI**

Group activities will be completed using group discussions and group conversations delivered through the CMS. Synchronous group interactions will take place via accessible video conferencing tools accessed via the CMS that allow for online document sharing. The instructor will ensure that accessibility requirements are met.

## Methods of Evaluation

**Method**

Homework

**Integration**

All homework will be used as formative assessments and will be graded on completeness and accuracy. Students will be graded on their ability to apply mathematical concepts to answer assigned problems on matrix operations, vector spaces, and linear transformations.

**DE Adaptations for MOE**

Students will access homework assignments via the CMS. Students will complete homework assignments with paper and pencil, then submit their solutions through the CMS by uploading a photo or scan of their work,
by submitting solutions typed up using a rich text editor or LaTeX, or via a mathematics assessment system such as MyOpenMath. The instructor will ensure that accessibility requirements are met. Students will receive feedback of their work through the CMS within one week after the assignment due date.

**Method**

Exams/Tests

**Integration**

Exams will be used as summative assessments and will be graded on completeness and correctness. Students will be evaluated for their conceptual understanding and the correct application of calculating eigenvalue/eigenvector pairs, solving systems of linear equations using Gaussian elimination, and finding inverses of nonsingular matrices.

**DE Adaptations for MOE**

Students will complete exams with paper and pencil, then submit their solutions through the CMS by uploading a photo or scan of their work, by submitting solutions typed up using a rich text editor or LaTeX, or via a mathematics assessment system such as MyOpenMath. Students will receive feedback of their work through the CMS.

**Method**

Final Performance

**Integration**

The final exam will be used as a summative assessment and will be graded on correctness and completeness. Students will be evaluated on course objectives such as their ability to perform vector and matrix operations, find the reduced row-echelon form of a matrix using Gauss-Jordan elimination, and obtaining an orthonormal basis for a vector space using the Gram-Schmidt process.

**DE Adaptations for MOE**

Students will access the final exam through the CMS. Students will complete the final exam with paper and pencil, then submit their solutions through the CMS by uploading a photo or scan of their work, by submitting solutions typed up using a rich text editor

or LaTeX, or via an integrated mathematics assessment system such as MyOpenMath. The instructor will ensure accessibility requirements are met. Students will receive feedback of their work through the CMS within one week after the assignment due date.

**Method**

Quizzes

**Integration**

Quizzes will be used as formative assessments and will be graded on completeness and correctness. Students will be graded on linear algebra topics such as calculating determinants of square matrices and interpreting the results, finding bases for matrix-generated spaces, such as row space, column space, and null space, and calculating the dimension of a vector space.

**DE Adaptations for MOE**

Students will access quizzes through the CMS. Students will complete quizzes with paper and pencil, then submit their solutions through the CMS by uploading a photo or scan of their work, by submitting solutions typed up using a rich text editor or LaTeX, or via an integrated mathematics assessment system such as MyOpenMath. The instructor will ensure accessibility requirements are met. Students will receive feedback of their work through the CMS within one week after the assignment due date.

**Method**

Class Work

**Integration**

Class work will be used as a formative assessment and will be graded on completeness, correctness, and clarity. Students will write mathematical proofs of basic results in linear algebra, such as linear independence and properties of subpsaces, using appropriate proof-writing techniques.

**DE Adaptations for MOE**

Students will access class work through the CMS. Students will complete classwork with paper and pencil, then submit their solutions through the CMS by uploading a photo or scan of their work, by submitting solutions typed up using a rich text editor or LaTeX, or via an integrated mathematics assessment system such as MyOpenMath. The instructor will ensure accessibility requirements are met. Students will receive feedback of their work through the CMS within one week after the assignment due date.

**Method**

Oral Presentation

**Integration**

Students will research and orally present a report on some of the multicultural origins of and the diverse set of mathematicians who contributed to linear algebra and other fields of mathematics. Example topics may include the strategies ancient cultures, such as the Babylonians, the Egyptians, or the Chinese, used to solve linear equations or systems of linear equations. Or students may present a report on an influential mathematician, such as René Descartes, Emily Noether, Alan Turing, or Alberto Pedro Calderón, and their contributions to linear algebra and/or other mathematical fields. The oral presentations will be evaluated via a rubric and/or individual instructor feedback.

**DE Adaptations for MOE**

Students will access instructions for the assignment through discussion forums in the CMS. Students will post written research reports to the discussion forums within the CMS. Once their own report is posted, they will review and reply to other students' reports. The instructor will ensure accessibility requirements are met. Students will receive feedback of their work through the CMS via a rubric and/or individual instructor feedback within one week after the assignment due date.

**Method**

Self-Evaluation

**Integration**

Self-evaluation essays will be used as formative assessments and will be graded on thoughtfulness, completeness of self-reflection, application of critical thinking, and clarity of presentation. Students will recognize their personal growth and plan how to improve in areas they are struggling. Students will reflect on the study skills and habits to be successful in linear algebra.

**DE Adaptations for MOE**

Self-evaluation instructions will be delivered to students via the CMS. Self-evaluation essays will be submitted via the CMS as an assignment. The instructor will ensure that accessbility requirements are met. Students will receive feedback of their work through the CMS within one week after the due date.

## Assignments

**Assignment Type**

Writing

**In-class and/or outside of class**

In-class

**Formative or Summative**

Summative

**Assignment**

Answer all questions below. Be sure to show all your work and justify all your answers. Your work will be graded based on the completeness and correctness of your work and answers.

1. Solve the system of equations below by converting the system to its associated augmented matrix, then using elementary row operations to find the reduced row-echelon form of the system.

x + 3y - 2z = -11
2x + y + 4z = 12
x - y - z = 0

2. If possible, express the vector [2; -4; -1] as a linear combination of the vectors [1; 1; -2] and [1; -3; 0].

3. Determine if the the vectors [3; 0; 0], [1; -2; 0], and [-5; 4; 3] are linearly independent. Justify your answer.

4. Given matrix A = [0 3 1; -2 0 -4] and matrix B = [1 0 -2 -3; 4 0 1 -1; 0 -2 -1 0], find the product matrix AB.

5. Find the inverse of matrix A = [1 1 0; 2 3 0; 0 -1 1].

**How assignment will be adapted in online format**

This assignment will be delivered to students via the CMS. Students will solve the assignment problems with paper and pencil, then submit their solutions through the CMS by uploading a photo or scan of their work. The instructor will ensure that accessibility requirements are met. Students will receive feedback of their work through the CMS within one week after the due date.

**Assignment Type**

Writing

**In-class and/or outside of class**

Outside of class

**Formative or Summative**

Formative

**Assignment**

Prove each statement below using appropriate proof writing techniques. Your proofs will be graded based on the completeness and correctness of your arguments.

Remember that mathematical proof writing can be challenging when first learning. Do your best, and don't be afraid to make mistakes. Mistakes are a great learning experience! If you find yourself struggling, please reach out to the instructor to discuss strategies for how to approach these kinds of problems. Also, you are encouraged to discuss the problems with other students, though each student must write and submit their own proofs.

1. Prove that the zero vector of R^n is contained in the span of any collection of vectors of R^n.

2. Suppose {v_1, ..., v_m} is a linearly independent set in R^n, and that v_{m+1} is not in span(v_1, ..., v_m). Prove that {v_1, ..., v_m, v_{m+1}} is also linearly independent.

3. Prove that a linear combination of any number of solutions of a homogeneous equation is a solution to the same homogeneous equation.

4. Let B = {v_1, v_2, v_3} be a basis of R^3. Suppose A is a nonsingular 3 x 3 matrix. Show that C = {Av_1, Av_2, Av_3} is also a basis of R^3.

5. Let v_1, v_2, v_3 be vectors in R^4. Prove that span(v_1, v_2, v_3) is a subspace of R^4.

6. Let A be an n x n matrix with eigenvalue λ. Show that the set of eigenvectors of A associated with λ is closed under scalar multiplication.

**How assignment will be adapted in online format**

This assignment will be delivered to students via the CMS. Students will solve the assignment problems with paper and pencil, then submit their solutions through the CMS by uploading a photo or scan of their work. The instructor will ensure that accessibility requirements are met. Students will receive feedback of their work through the CMS within one week after the due date.

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**Assignment Type**

Reading

**In-class and/or outside of class**

In-class
Outside of class

**Formative or Summative**

Formative

**Assignment**

You will give a short oral presentation (between two and five minutes) on the multicultural origins of linear algebra and/or the diverse set of mathematicians who contributed to linear algebra. Choose one of the following:

1. Research and present on an ancient civilization or culture and the techniques they developed to solve systems of linear equations and/or other mathematical contributions. Examples civilizations you could research include the Babylonian, Chinese, Indian, Arabic, Egyptian, Greek, Roman, or Mayan civilizations. You may use any appropriate sources for your research, but here are some resources to help you get started:
- "Solving a System of Linear Equations Using Ancient Chinese Methods", by Mary Flagg. [https://digitalcommons.ursinus.edu/cgi/viewcontent.cgi?article=1001&context=triumphs_linear]
- "A Brief Study of Some Aspects of Babylonian Mathematics", by Tom Zara. [https://math.hawaii.edu/~mchyba/documents/syllabus/Math499/Babylonians/Babylonian.pdf]
- "Egypt: Arithmetic and Algebra", by Robert Gardner. [https://faculty.etsu.edu/gardnerr/3040/Notes-Eves6/Eves6-2-8.pdf]

2. Research and present on the life and contributions of one of the diverse set of mathematicians who have contributed to linear algebra or other mathematical fields. Examples of mathematicians you could research include Emmy Noether, Al Khawarizmi, René Descartes, Alan Turing, Alberto Pedro Calderón, Hypatia of Alexandria, Michela Redivo-Zaglia, David Blackwell, Katherine Johnson, and Carl Friedrich Gauss. You may use any appropriate sources for your research, but here are some resources to help you get started:

- "Biographies of Women Mathematicians", hosted by Agnes Scott College. [https://mathwomen.agnesscott.org/women/women.htm] A collection of short biographies of influential women in mathematics.
- "MacTutor Index", hosted by the University of St Andrews. [https://mathshistory.st-andrews.ac.uk/] An index of biographies over 3000 mathematicians. Includes lists of mathematicians from different categories, including African mathematicians, ancient Islamic mathematicians, female mathematicians, African-American mathematicians, and mathematicians organized by birth country.

Your presentation will be evaluated using a detailed rubric and/or individual instructor feedback.

**How assignment will be adapted in online format**

Students will access instructions for the assignment through discussion forums in the CMS. Students will post written reports to the discussion forums within the CMS. Once their own report is posted, they will review and reply to other students' reports. The instructor will ensure accessibility requirements are met. Students will receive feedback of their work through the CMS via a rubric and/or individual instructor feedback within one week after the assignment due date.

## Course Materials

**Textbooks**

Poole, David. (2026). Linear Algebra: A Modern Introduction. Cengage. ISBN: 9798214013053

O'Leary, Michael L. (2021). Linear Algebra. Wiley. ISBN: 9781119437444

Anton, Rorres, Kaul (2019). Elementary Linear Algebra-Application Version. Wiley. ISBN: 9781119406723

R. Larson (2017). Elementary Linear Algebra. Cengage. ISBN: 9781305658004

**Other Resources**

GNU Octave. (9.2.0) This is open-source software similar to MatLab. (https://octave.org)

**Open Educational Resources**

Davis, Zachlin. Linear Algebra: An Interactive Introduction. (https://ximera.osu.edu/oerlinalg/LinearAlgebra)

## Class Size Information

**Class Size**

30

**Class Size Category**

C - Remedial or advanced math 30

## Diversity and Inclusion

Course Design and Materials: Course will incorporate diverse perspectives, authors, and examples that reflect a variety of cultures, identities, and lived experiences. Instructional materials will be reviewed regularly to ensure representation, inclusivity, and alignment with equity-minded practices across disciplines.

Inclusive Learning Environment: Instructors will establish classroom norms and policies that promote respect, civil discourse, and belonging in both online and face-to-face classes. Clear expectations for communication and engagement will support a learning space where all students feel valued and heard.

Accessible Instruction: Course content will be delivered using accessible design. Materials will follow accessibility guidelines within the CMS, including captioned media, readable document formats, and multiple means of engagement to support diverse learning.

Equitable Teaching Practices: Instructors will use transparent and grading criteria, varied assessment methods, and timely feedback to promote fairness and student success. Opportunities for revision, reflection, and multiple demonstrations of learning may be incorporated when appropriate to the discipline.

Culturally Responsive Pedagogies: Instructional strategies will encourage critical thinking about diverse perspectives and systems of power relevant to the course content. Faculty will foster opportunities for students to connect course material to real-world contexts.

Ongoing Reflection and Improvement: Faculty will engage in continuous professional development related to IDEAA principles and reflect on course practices using metacognition to identify opportunities for increased equity, inclusion, and accessibility.

**Explain how diversity and inclusion(e.g., gender, culture/race, sexuality, etc.) is infused into the course.**

In the objectives and course content, we included the requirement to research and discuss the multicultural origins of and the diverse set of mathematicians who contributed to linear algebra and other fields of mathematics. Assignments support this requirement by giving students the opportunity to research, present on, and discuss the mathematical contributions from a wide range of cultures and from mathematicians of different genders, races, and backgrounds.

**Describe how assignments, instruction, evaluation, course content, and interactions are contextualized for diverse learners promoting an equitable course.**

The example assignment on proofs demonstrates how instructions can be written to encourage students to approach difficult problems with a growth mindset, to accept mistakes as part of the learning process, and to seek support when needed. In the methods of instruction, we have specified that during discussions and lecture, the instructor will encourage students to share their own experiences in mathematics, discuss strategies for succeeding in mathematics, and seek student feedback of their grasp of course content. The listed methods of evaluation include multiple formative active-learning assessments, allowing students the opportunity to receive and review instructor feedback to correct mistakes/fill gaps in their understanding prior to completing summative assessments. The course materials have been revised to include an OER option to allow students of all socioeconomic backgrounds to fully participate in the course.

Mathematics can be a difficult subject, and many students have developed math anxiety, a fear of making mistakes, and feelings of inadequacy towards math. The above changes are intended to encourage students of all backgrounds and abilities by communicating that mistakes part of the process of learning mathematics, that all students struggle with mathematics to some degree, and that success in mathematics can be achieved by all students through incremental effort and improvement.

## Interactions

**Explain how the course will incorporate student-to-student interaction.**

For both face-to-face and online modalities, group work will give students the opportunity to collaborate on and practice linear algebra problems, such as writing proofs of the properties of vector spaces, determining if a set of vectors is linearly independent, and solving systems of linear equations using elementary row operations. In both modalities, students will be given frequent opportunities to discuss how to apply concepts and techniques in such areas of linear algebra as matrix and vector operations, analyzing vector spaces, and synthesizing linear transformations.

**Explain how the course will incorporate instructor-to-student interaction.**

In both face-to-face and online modalities, instructors will use discussions to interact with students, discussing the multicultural origins of and the diverse set of mathematicians who contributed to linear algebra and other fields of mathematics, and they will discuss their prior positive and negative experiences with mathematics and strategies to success in mathematics. Also, instructors will clarify concepts and pose questions about various linear algebra concepts, such as linear algebraic terminology, the theory of linear algebra, and how to solve problems such as finding the basis of a vector space, computing the inverse of a nonsingular matrix, and computing the determinant of a square matrix. In both face-to-face and online modalities, instructors will encourage student feedback and interaction with the instructor, and the instructor will provide feedback to students on formative and summative assessments.

**Explain how the course will incorporate student-to-content interaction.**

In both face-to-face and online modalities, students will reference accessible materials such as textbooks, written lecture materials or transcripts of lectures, illustrative images, charts and graphs, or video or audio lectures. In-class exercises and/or at-home assignments will allow students to practice content material such as calculating the eigenvalues and eigenvectors of a matrix, finding a basis for a vector space, and determining if a transformation is linear.

**Explain how the course will incorporate student-to-self interaction (metacognitive).**

In both face-to-face and online modalities, students will use self-evaluation essays to reflect on their personal growth and plan how to improve in areas they are struggling. Students will reflect on the study skills and habits to be successful in linear algebra. This course emphasizes thinking both logically and flexibly, and it encourages students to consider different methods of solutions by engaging in discussions, assessments, and writing activities.

Key: 2114