Quinsigamond Community College School of Math, Science, & Engineering

Instructor's Information

Instructor: Professor XX (she/her/hers)
Office: 200A
Email: xxxxx@qcc.mass.edu
Telephone: 508-854-xxxx

Course Information

Course: MAT 243 Linear Algebra – Section XX
Meets: Mondays and Wednesdays from 9:30am – 10:45am
Room: 177A
Credits: 3 credits
Semester: Fall 2024

Course Description

This course covers systems of linear equations, matrices, reduced echelon forms, vectors in Rn, linear independence and transformations, matrix operations, inverse of a matrix, determinants, vector space, rank, subspaces, bases, eigen vectors and eigen values, the characteristic equations, diagonalization, complex eigen values, numerical methods for solving linear systems, and orthogonality. Students learn to use linear algebra to solve problems in differential equations, statistics, and engineering design. Students also use mathematical software to solve higher order systems of equations and matrices.

Corequisites

MAT 238 Differential Equations

Required Textbook/Materials/Website

Textbook: *Linear Algebra and Its Applications*, by Lay, 6th edition, Pearson © 2021
Website: Access to Pearson's MyLab Math

Student Learning Outcomes

Upon completion of this course, students will be able to:

1. Solve systems of linear equations using matrices.
2. Perform matrix operations. Find the inverse of a square matrix, when possible.
3. Compute the determinant of a square matrix.
4. Use matrices as representations of linear transformations and their images.
5. Identify vector spaces and subspaces. Determine spanning sets, bases, dimension, and coordinate systems for such spaces.
6. Find the eigenvalues and corresponding eigenvectors of a matrix. Find a basis for the eigenspace. Diagonalize a matrix, when possible.
7. Find the orthogonal projection of one vector onto another.

Course Topics & Required Section Readings/Assignments

Linear Equations in Linear Algebra

- System of Linear Equations
- Row Reduction and Echelon Forms
- Vector Equations
- The Matrix Equation $A\mathbf{x} = \mathbf{b}$
- Solution Sets of Linear Systems
- Applications of Linear Systems
- Linear Independence
- Introduction to Linear Transformations
- The Matrix of a Linear Transformation

Matrix Algebra

- Matrix Operations
- The Inverse of a Matrix
- Characterizations of Invertible Matrices
- Partitioned Matrices
- Matrix Factorizations
- Subspaces of $\boldsymbol{R}^n$
- Dimension and Rank

Determinants

- Introduction to Determinants
- Properties of Determinants
- Cramer's Rule, Volume, and Linear Transformations

Vector Spaces

- Vector Spaces and Subspaces
- Null Spaces, Column Spaces, and Linear Transformations
- Linearly Independent Sets; Bases
- Coordinate Systems
- The Dimension of a Vector Space
- Change of Basis

Eigenvalues and Eigenvectors

- Eigenvectors and Eigenvalues
- The Characteristic Equation
- Diagonalization
- Eigenvectors and Linear Transformations
- Complex Eigenvalues
- Discrete Dynamical Systems
- Applications to Differential Equations
- Iterative Estimates for Eigenvalues

Orthogonality and Least Squares

- Inner Product, Length, and Orthogonality
- Orthogonal Sets
- Orthogonal Projections

- The Gram-Schmidt Process
- Least-Squares Problems
- Inner Product Spaces
- Applications of Inner Product Spaces

Symmetric Matrices and Quadratic Forms

- Diagonalization of Symmetric Matrices
- Quadratic Forms

Instructional Objectives

- Solve systems of linear equations.
- Determine if a system is consistent.
- Determine if the solution is unique.
- Row reduce a matrix to echelon form and reduced row echelon form.
- Write a system of linear equations as a vector equation.
- Define a linear combination of vectors.
- View a linear combination of vectors as the product of a matrix and a vector.
- Describe solutions to homogeneous and nonhomogeneous systems.
- Determine if a set of vectors is linearly independent.
- Define a linear transformation and find the images of vectors under a linear transformation.
- Find the standard matrix of a linear transformation.
- Compute the product of matrices by using properties of matrix multiplication.
- Find the inverse of a matrix by using the algorithm for finding the inverse of a matrix.
- Use the Invertible Matrix Theorem to decide if a given matrix is invertible.
- Find an LU factorization of a matrix.
- Define a subspace of $\boldsymbol{R}^n$ and use it to determine the column space and the null space of a matrix.
- Find basis for subspaces.
- Determine the dimension of a subspace and the rank of a matrix.
- Compute the determinant of an $n \times n$ matrix using row operations.
- Use Cramer's Rule to solve a system of linear equations.
- Use the definition of vector space to determine if a given set is a vector space.
- Find a subspace of a vector space by using the definition.
- Determine the kernel and range of a linear transformation.
- Use the definition and determine if a set of vectors is a linearly independent set.
- Determine bases for the null space and column space of a matrix.
- Find the coordinate vector of a given vector relative to a basis.
- Determine the dimension of a vector space.
- Find the row space of a matrix.
- Determine the change-of-coordinates matrix from one basis to another.
- Find the eigenvectors and eigenvalues of a square matrix and basis for the corresponding eigenspace.
- Diagonalize a matrix using the Diagonalization Theorem.
- Find complex eigenvalues of a matrix when they exist.
- Define length, distance, and perpendicularity in terms of the Inner Product.

- Show that a set of vectors is an Orthogonal Set using the definition.
- Calculate orthogonal projections.
- Use the Gram-Schmidt Process to construct an orthogonal basis for a given subspace.
- Determine if a vector space is an inner product space.
- Orthogonally diagonalize a symmetric matrix.
- Make a change of variable that transforms a quadratic form into a quadratic form with no cross-product term.

Grading Breakdown

20% Homework
10% Quizzes
10% <Attendance>
35% Exams
25% Comprehensive Final Exam

Grade	Range	Grade	Range	Grade	Range
A	95 – 100	B –	80 – 82	D +	67 – 69
A –	90 – 94	C +	77 – 79	D	63 – 66
B +	87 – 89	C	73 – 76	D –	60 – 62
B	83 – 86	C –	70 – 72	F	0 – 59

Teaching Procedures

Most classes will be a combination of lectures, group activities, and in-class assignments. You will be given homework assignments to be completed outside of class. Occasionally, a quiz or exam will be given in class.

Attendance Policy

Students are expected to attend all classes for the entire period. Attendance will be taken in every class. If you are absent from class, proper documentation will excuse your absence.

Diversity, Equity, and Inclusion Statement for the School of Math & Science

The School of Math and Science is motivated to teach and learn from the diverse community we have at QCC. In Science, Technology, Engineering, and Mathematics (STEM), it is advantageous to approach problems from multiple perspectives. The power of diversity, equity and inclusion allows us to persevere and overcome challenges.

The faculty of the School of Math and Science pledge to help students meet the demands of STEM regardless of race/ethnicity, gender identity and expression, sexual orientation, faith, abilities/disabilities, age, socioeconomic background, political leaning, ancestry, national origin, home language and all other identities. We are dedicated to nurturing a culture of collaboration, mutual respect and understanding; and to empowering members of our community to embrace their full potential.

Accessibility Statement

Quinsigamond Community College is committed to providing access and inclusion for all persons with disabilities. Students who require an accommodation in this course should notify the professor as soon as possible. Students are responsible for forwarding the Accommodation Letter to the professor (via email or hard copy). Students may request accommodations at any time during the semester, which begin upon receipt (accommodations are not retroactive). Please discuss any barriers which may arise during the semester with your professor or coordinator in the Student Accessibility Services office.

Contact Information for Student Accessibility Services (SAS):
Call: 508-854-4471
Sorenson Video Phone: 508-502-7647
Email: disabilityservices@qcc.mass.edu

Services for Veterans

If you are a veteran of the US Armed Forces, please visit the Veteran Affairs Office located in 258A (Administration Building) or contact them at veteranaffairs@qcc.mass.edu.

Academic Honesty and Plagiarism

Our purpose of education is to seek the truth; this work requires trust and honesty between teacher and student. If we are not honest about what we know and don't know, our learning will always be impaired. Because our teaching and learning depends on this honest communication, we expect all students to understand what plagiarism is and why it is unacceptable.

Plagiarism means taking someone else's ideas or words and presenting them as one's own. The offense can take many forms including cheating on a test, passing in a paper taken from the Internet or from another student, or failing to properly use and credit sources in an essay. Sometimes the issue is subtle, involving getting too much help on an assignment from someone else. In every instance, plagiarism means cheating both oneself and the owner of the source. Since cheating sabotages a student's learning experience, consequences range from no credit for the assignment to failure for the course and possible expulsion from the college.

The penalty for getting caught cheating in this course is a failure of the quiz or test, or failure of the entire course. This is solely at the discretion of the instructor.

For further information concerning plagiarism, refer to the QCC Student Handbook.

Math Center

The Math Center provides free, drop-in tutoring assistance for students in any QCC mathematics course. Located on the second floor of the Harrington Learning Center (HLC), the Math Center is a welcoming place where students have the opportunity to work collaboratively with tutors and classmates. Students can work intensively to improve their mathematical skills or simply drop by to ask a few questions. In addition to tutoring, the Math Center houses various math-related resources, and

computers and software for math coursework. Visit their website for details and the semester schedule: https://www.qcc.edu/services/tutoring/math-center

Assignment & Test Schedule

<list all assignments, quizzes, and exam dates>