# MATH 631: Linear Algebra
## *Fall 2024 Course Syllabus*

**NJIT Academic Integrity Code**: All Students should be aware that the Department of Mathematical Sciences takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

It is my professional obligation to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating or plagiarizing will be subject to disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

## COURSE INFORMATION

**Course Description**: A graduate-level treatment of linear algebra with emphasis on mathematical rigor and depth of understanding. Topics include linear spaces, duality, matrices, determinants, spectral theory, inner product spaces, and matrix decomposition.

**Number of Credits**: 3

**Prerequisites**: MATH 222 and MATH 337, or departmental approval.

**Course-Section and Instructors:**

| Course-Section | Instructor |
|---|---|
| Math 631-001 | Professor T. Askham |

**Office Hours for All Math Instructors**: Fall 2024 Office Hours and Emails

**Required Textbook**:

There is no required textbook for this course. Please see the recommended texts below.

- Optional: Linear Algebra and its Applications by Peter Lax (2nd ed.) Wiley 978-0471751564
- Optional: Numerical Linear Algebra by L. N. Trefethen and D. Bau (1st Ed) SIAM
- Optional: Linear algebra Hoffman, Kenneth, and Ray Kunze (2nd Ed), Prentice-Hall

**University-wide Withdrawal Date**: The last day to withdraw with a **W** is **Monday, November 11, 2024**. It will

be strictly enforced.

## COURSE GOALS

**Course Objectives**

- To develop a deeper understanding of linear maps in a finite dimensional setting.
- To gain intuition for core concepts, including: eigenvalues and eigenvectors, singular value decompositions, duality, rank, and determinants.
- To master the basics of linear algebra practice, including: solving a system of equations and applying matrix decompositions

**Course Outcomes**

- Students recognize when linear algebra concepts can be applied to a variety of mathematical and engineering problems.
- Students demonstrate the ability to apply numerical methods to solve linear algebra problems with accuracy, precision, and efficiency.
- Students demonstrate greater ability in making and understanding rigorous arguments.

## POLICIES

**DMS Course Policies**: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

**Grading Policy**: The final grade in this course will be determined as follows:

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|---|---|
| **Participation and Reading questions** | 10% |
| **Homework** | 30% |
| **Midterm Exam** | 30% |
| **Final Exam** | 30% |

Your final letter grade will be based on the following tentative curve.

| | | | |
|---|---|---|---|
| **A** | 90 - 100 | **C+** | 76 - 79 |
| **B+** | 86 - 89 | **C** | 60 - 75 |
| **B** | 80 - 85 | **F** | 0 - 59 |

**Attendance Policy**: Attendance at all classes is **mandatory**. Please make sure you read and fully understand the Math Department's Attendance Policy.

**Email and Canvas:** Regularly check your NJIT email account and the course information posted on Canvas for class assignments and announcements from your instructor.

**Reading Questions:** Each week, a selection of the course notes will be assigned for you to read. You should

read this material and prepare 2-3 questions about the material for discussion **before the Monday lecture**. Bring these questions with you to class. Questions could be about exercises that are not assigned, extensions of the material, special cases, weird examples, confusing parts of proofs, proposing alternate proofs, potential typos in the notes, etc.

**Homework:** Homework problem sets will be assigned regularly via Canvas and may include problems requiring basic coding in MATLAB or Python.

- You should attempt all of the problems **before the Wednesday lecture**. We will discuss a subset of these in small groups on Wednesdays and present solutions to the class. On the weeks without a Wednesday lecture (Oct 28 and Nov 25) these problems should be attempted before the Monday lecture.
- This homework must be clearly legible to receive full credit.
- There will be a portion of the homework grade based on completeness and I will provide detailed feedback on at least one problem, taking into account writing style and clarity.
- **I take issues of academic dishonesty very seriously:**
    - The logic of a proof must be completely clear and you must cite sources to receive full credit.
    - Collaboration with other students is encouraged, but you are not allowed to consult the written work of others in preparing your own solutions.
    - No consultation with internet sources outside of the textbook and approved online resources is allowed.
    - Any evidence of the use of artificial intelligence services to answer homework questions will result in a zero for the assignment. Repeated violations will result in a failing grade for the course.

**Course Format**: Each week, except for the first week (9/2-9/6), the week of the midterm (10/28-11/1), and the week of Thanksgiving (11/25-11/29), will be run as follows

- Monday lecture: we will review the material from the assigned reading and address your reading questions (as described above). We will focus on proofs and examples and we will clarify any questions about the definitions as requested.
- Wednesday lecture: we will split into groups to work on select homework questions. Each group will then present their solution on the board.

On the exceptional weeks, there is only one day of instruction (Wednesday 9/2, Monday 10/28 and Monday 11/25). This will be treated like a Monday lecture, with review and questions. The homework corresponding to this material will be due the following week.

**Exams**: As of now, all exams will be administered in person. Midterm exams will be held during a regular class meeting; the location and date of the final will be provided to you when they are set.

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|---|---|
| Midterm Exam | October 30th (in lecture) |
| Final Exam Period | December |

The final exam will cover all of the material taught in the entire course. Make sure you read and fully understand the Math Department's Examination Policy. This policy will be strictly enforced.

**Makeup Exam Policy**: There will be **NO MAKE-UP QUIZZES OR EXAMS** during the semester. In the event an exam is not taken under rare circumstances where the student has a legitimate reason for missing the exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the Math Department Office/Instructor that the exam will be missed.

**Cellular Phones**: All cellular phones and other electronic devices must be switched off during all class times.

## ADDITIONAL RESOURCES

**Further Assistance**: For further questions, students should contact their instructor. All instructors have regular office hours during the week. These office hours are listed on the Math Department's webpage for Instructor Office Hours and Emails.

**Accommodation of Disabilities**: The Office of Accessibility Resources and Services (OARS) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you need accommodation due to a disability, please contact the Office of Accessibility Resources and Services at oars@njit.edu, or visit Kupfrian Hall 201 to discuss your specific needs. A Letter of Accommodation Eligibility from the office authorizing student accommodations is required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Office of Accessibility Resources and Services (OARS) website at:

https://www.njit.edu/accessibility/

**Important Dates** (See: Fall 2024 Academic Calendar, Registrar)

| Date | Day | Event |
|---|---|---|
| September 2, 2024 | Monday | Labor Day |
| September 3, 2024 | Tuesday | First Day of Classes |
| September 9, 2024 | Monday | Last Day to Add/Drop Classes |
| November 11, 2024 | Monday | Last Day to Withdraw |
| November 26, 2024 | Tuesday | Thursday Classes Meet |
| November 27, 2024 | Wednesday | Friday Classes Meet |
| November 28 to December 1, 2024 | Thursday and Sunday | Thanksgiving Recess - Closed |
| December 11, 2024 | Wednesday | Last Day of Classes |
| December 12, 2024 | Thursday | Reading Day 1 |
| December 13, 2024 | Friday | Reading Day 2 |
| December 15 to December 21, 2024 | Sunday to Saturday | Final Exam Period |

# Course Outline

| Lecture | Chapter | Topic |
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|---|---|---|
| 9/4 | 1.1-1.2 | Overview of class and introduction to vector spaces |
| 9/9 and 9/11 | 1.2-1.4.1 | Bases, subspaces, and introduction to linear maps |
| 9/16 and 9/18 | 1.4.2-1.6.1 | Linear maps, solvability, introduce duality |
| 9/23 and 9/25 | 1.6.2,2.1-2.3 | Finish duality, matrix review |
| 9/30 and 10/2 | 2.4.1-2.5 and 3 | Finish Gaussian elimination review and differential equations review |
| 10/7 and 10/9 | 4.1-4.7 | Determinant |
| 10/14 and 10/16 | 4.8 and 5.1-5.3 | More determinant, trace, and beginning eigenvalues |
| 10/21 and 10/23 | 5.4-5.5.4 | Spectral theorem |
| 10/28 | 5.5.5-5.6 | Minimal polynomials and a warning about eigenvalues. |
| 10/30 | | Midterm exam |
| 11/4 and 11/6 | 6.1-6.4 | Inner product spaces and duality in inner product spaces |
| 11/11 and 11/13 | 6.5-6.8 | Least squares problems, operator norms, and convergence |
| 11/18 and 11/20 | 7.1-7.4 | Spectral theory for self-adjoint operators |
| 11/25 | 7.5 | Positive definite operators |
| 12/2 and 12/4 | 7.6 and 8.1 | SVD and condition number |
| 12/9 and 12/11 | 8.2 | Iterative methods for eigenvalues and eigenvectors |