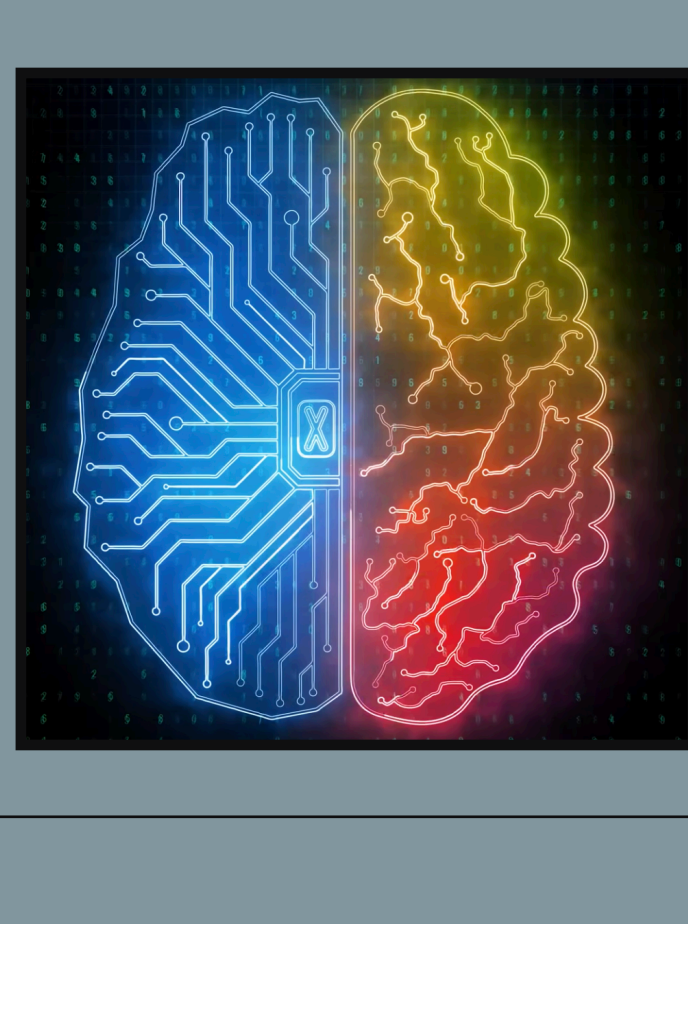


# Linear Algebra

## Part II



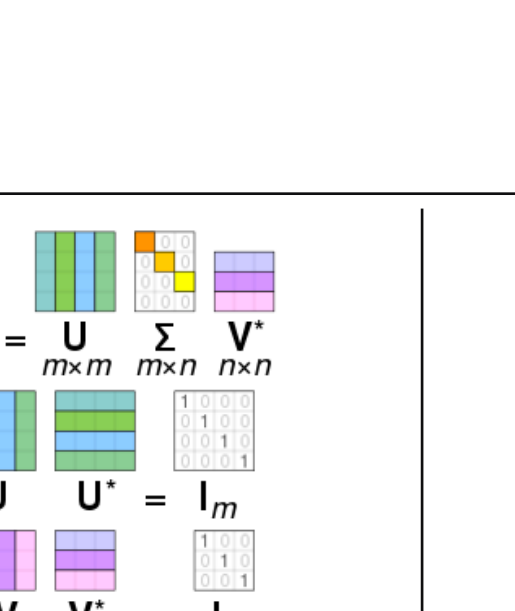
MTH 225

**Dr. John Gemmer:** gemmerj@wfu.edu  
**Office:** Manchester 388  
**Course Website:** <http://users.wfu.edu/gemmerj/math225S24.html>  
**Canvas:** The course syllabus and grades will be posted on Canvas  
**Office Hours:** T 9:00-10:00, W 1:00-3:00, Th 9:00-10:00, 12:30-1:30.  
**Class Meeting Times:** MWF 9:00-9:50  
**Class Location:** Kirby 103  
**Piazza:** <https://piazza.com/wfu/spring2024/mth225/info>  
**Study Sessions:** Wednesdays 7-9, Thursdays 7-9 in Manchester Hall

## COURSE DESCRIPTION

This is a second course in linear algebra. In your first linear algebra course the emphasis was on subspaces and linear maps on Euclidean space. In this course we will study finite dimensional vector spaces and linear maps where the field of scalars can be the complex numbers. In addition to reviewing concepts covered before in this slightly more general context, we will study some further topics that are useful in many contexts. Central course goals include obtaining and using special forms of linear maps. Linear algebra is central to applications such as Google PageRank, sabermetrics, machine learning, linear models, principal component analysis, quantum mechanics, and graph theory, as well as to pure mathematics. The primary goal of this course is to develop an understanding of many of the basic tools in linear algebra so that you can later apply it to many different contexts.

## REQUIREMENTS



**Prerequisites:**  
MTH 121/205 and MTH 117

## OBJECTIVES

<p><b>Master Abstract Vector Spaces</b></p>	<p><b>Master Matrix Decompositions</b></p>	<p><b>Master Linear Transformations</b></p>
<p><b>Learn Applications of Linear Algebra</b></p>	<p><b>Learning to collaborate</b></p>	<p><b>Improve proof writing</b></p>

## CLASS STRUCTURE

**Class Time: 2.5 Hrs/Week**

- Ask questions, discuss
- Lectures
- Group work
- Diagnostic Quizzes

**Outside Class Time: 9-12 Hrs/Week**

- Read material
- Solve problems
- Write Solutions
- Check basic understanding

## EVALUATION

We focus on learning and mastery. You are guaranteed the following grades if your final percentage lies within the following ranges:

90-92.9: A-	93-100: A	
80-82.9: B-	83-86.9: B	87-89.9: B+
70-72.9: C-	73-76.9: C	77-79.9: C+
60-62.9: D-	63-66.9: D	67-69.9: D+

### Undergraduate Student Evaluation

- Classworks (5%)**  
Structured in class group assignments  
Grades based on attendance
- Quizzes (10%), at least 1 dropped**  
5-10 minutes  
In class on Fridays
- Weekly Homework (25%), at least 1 dropped**  
Open book, collaboration allowed with citation  
Homework is due on Friday in class
- Two summative assessments (30%)**  
In class, closed notes
- Final Exam (30%)**  
Comprehensive  
In class, closed notes

**Piazza:** This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates, and myself. Rather than emailing questions to the me, I encourage you to post your questions on Piazza.

**Classworks:** Throughout the course there will be several class works. These consist of structured group assignments that will be completed during class time. These assignments will generally be exploratory allowing students to synthesize concepts through a "hands on" approach. Classworks will be graded based on attendance.

**Quizzes:** On most Fridays there will be a short 5-10 minute in-class quizzes. These quizzes will consist of a very short problem that will test your knowledge of the prior lectures and homework. These quizzes are to help both the students and the instructor understand concepts that students may be struggling with. All quizzes will be announced in class. There will be no "pop" quizzes. There are no retakes for missed quizzes, however I will drop the lowest quiz score from your final grade.

**Weekly Homework:** Homework will be assigned most weeks on Thursday and will be due Friday in class the following week. Late homework will not be accepted under any circumstances. However, I will drop at least one homework assignment from your grade. While you are allowed to collaborate with your colleagues, homework must consist of solutions that show all steps, be your own work and be written clearly using complete sentences as appropriate (see homework policy). All homework will be submitted in class on paper. I will not accept digital versions of your homework.

**Summative Assessments:** There will be two in class summative assessments in the course and a cumulative final exam.

**Late Work Policy:** Except in very extreme circumstances, I do not accept late assignments or reschedule exams. If you have a situation in which you cannot make an exam for personal reasons, you must arrange accommodations with the instructor to schedule the exam **before the scheduled exam date**. If you have a legitimate emergency situation, I will make sure that all students in the course have access to the same exception to this policy.

**If you need to miss class due to a university sponsored activity, such as athletics. Please contact the faculty member as soon as possible to reschedule due dates.**

## COURSE ENVIRONMENT

### Names/Pronouns

You **deserve** to be addressed in the manner you prefer. To guarantee that I address you properly, you are welcome to tell me your pronoun(s) and/or preferred name at any time, either in person or via email.

**Diversity**  
We embrace diversity of age, background, beliefs, ethnicity, gender, gender identity, gender expression, national origin, religious affiliation, sexual orientation, and other visible and non-visible categories. **I do not tolerate discrimination.**

**Accessibility**  
I want you to succeed in this course. Wake Forest University provides reasonable accommodations to students with disabilities. If you are in need of an accommodation, then please contact me privately as early in the term as possible. Retroactive accommodations may not be provided. Students requiring accommodations must also consult the Center for Learning, Access, and Student Success (118 Reynolda Hall, 336-758-5929, <http://class.wfu.edu>). For personal issues, stress, health problems or life circumstances see [shs.wfu.edu/](https://shs.wfu.edu/). Contact me if you have other special circumstances. **I will find resources for you.**

**Title IX**  
You **deserve** a community free from discrimination, sexual harassment, a hostile environment, sexual assault, domestic violence, dating violence, and stalking. If you experience or know of a Title IX violation, you have many options for support and/or reporting; see [titleix.wfu.edu/](https://titleix.wfu.edu/).

**Emergency Fund**  
You **deserve** a learning environment in which all of your physiological and safety needs are met. If you are experiencing situations in which these needs are not met, e.g. you do not have adequate housing or sufficient food security, the Chaplain's Office has an emergency fund which can provide support: <https://chaplain.wfu.edu/care-support/chaplains-emergency-fund/>. In situations in which you need immediate assistance there is emergency funding available through the Department of Mathematics and Statistics. If you are in need of emergency help you are encouraged to reach out to a faculty member in the Department of Mathematics and Statistics who will work with the chair of the department to address your needs.

**Course Resources**  
The department has a limited amount of funding for class materials. If you cannot afford class materials, you are encouraged to contact the chair of the department privately as early in the term as possible. Due to the limited amount of funds, students must exhaust all other sources of funding before applying to the department for assistance.

**The Honor Code**  
At Wake Forest, we expect you to behave as honorable citizens of the class, the university, and the world as a whole. When you complete an assignment with your name on it, you are representing that everything you are turning in is your own work. That means that you do not copy from other students, textbooks, or websites. If at any time I become aware of cheating or plagiarism in this course, I will submit the information to the honor council.

## TENTATIVE COURSE CALENDAR

### Vector Spaces, Linear Transformations, Inner Product Spaces

- Week 1:**
- 1/15: MLK Day
  - 1/17: Solving systems of equations, **Ch 1: Section 1**
  - 1/19: Vector spaces and subspaces, **Ch 1: Section 2.**
- Week 2:**
- 1/22: Span, independence, basis and dimension, **Ch 1: Section 2**
  - 1/24: Linear transformations, nullity and rank, **Ch 1: Section 2**
  - 1/26: **Classwork #1, Homework #1 Due.**
- Week 3:**
- 1/29: Coordinate vectors, matrix of linear transformations, **Ch 1: Section 3**
  - 2/1: Changing basis, **Ch 1: Section 3**
  - 2/02: Eigenvalues and eigenvectors, **Ch 1: Section 4, Quiz #1, Homework #2 Due.**
- Week 4:**
- 2/05: Conditions for diagonalization, **Ch 1: Section 5**
  - 2/07: Complex inner product spaces, **Ch 2: Sections 1-2**
  - 2/09: **Classwork #2, Quiz #2, Homework #3 Due.**
- Week 5:**
- 2/12: Gram-Schmidt orthogonalization and projections, **Ch 2: Section 3**
  - 2/14: **Classwork #3**
  - 2/16: **Summative Assessment #1 (Chapter 1 and Chapter 2 Sections 1-2).**

### Spectral Theorems, Singular Value Decomposition, Functions of Matrices, Least Squares

- Week 6:**
- 2/19: Symmetric, Hermitian, Orthogonal and Unitary Matrices, **Ch 2: Section 4**
  - 2/21: Spectral Theorem (Hermitian) Part 1, **Ch 2: Section 4**
  - 2/23: Spectral Theorem (Hermitian) Part 2, **Ch 2: Section 4, Quiz #3, Homework #4 Due.**
- Week 7:**
- 2/26: SVD Part 1, **Ch 3**
  - 2/28: SVD Part 2, **Ch 3**
  - 3/01: SVD Part 3, **Ch 3, Quiz #4, Homework #5 Due.**
- Week 8:**
- 3/04: Square Root of of Matrices and Polar Decomposition, **Ch 4: Sections 1-2**
  - 3/06: Spectral Theorem (Normal), **Ch 4: Section 3**
  - 3/08: **Classwork #4, Quiz #5, Homework #6 Due.**
- Spring Break 3/09-3/17**
- Week 9:**
- 3/18: Matrix Exponential, **Ch 4, Section 4**
  - 3/20: Least Squares Solutions and Pseudoinverses, **Ch 4: Section 5**
  - 3/22: Pseudoinverses Continued **Ch 4: Section 5, Quiz #6, Homework #7 Due.**
- Week 10:**
- 3/25: Optimal Least Squares Solutions, **Ch 4: Section 6**
  - 3/27: **Classwork #5**
  - 3/29: **Summative Assessment #2 (Chapter 2, Chapter 3, and Chapter 4 Section 1-5).**

### Gerhgorin's circle theorem, Markhov Chains, Analytic Functions

- Week 11:**
- 4/01: Quadratic forms part 1, **Ch 4: Section 8**
  - 4/03: Quadratic forms part 2, **Ch 4: Section 8**
  - 4/05: Gershgorin's circle theorem part 1, **Ch 5, Quiz #7, Homework #8 Due.**
- Week 12:**
- 4/08: Gershgorin's circle theorem part 2, **Ch 5**
  - 4/10: Markhov chains, **Ch 6: Section 1**
  - 4/12: **Classwork #6, Quiz #8, Homework #9 Due.**
- Week 13:**
- 4/15: Perron's theorem part 1, **Ch 6: Section 2**
  - 4/17: Perron's theorem part 2, **Ch 6: Section 2**
  - 4/19: Frobenius theorem part 1, **Ch 6: Section 3, Quiz #9, Homework #10 Due.**
- Week 14:**
- 4/22: Frobenius theorem part 2, **Ch 6: Section 3**
  - 4/24: Fundamental theorem on Markov chains, **Ch 6: Section 4**
  - 4/26: Analytic functions of matrices part 1, **Ch 7, Quiz #10, Homework #11 Due.**
- Week 15:**
- 4/29: Analytic functions of matrices part 2, **Ch 7**
  - 5/01: **Classwork #7, Homework #11 Due.**

**Final Exam: 5/04, 9:00 AM.**

## SUCCESS

<p>Attend class</p>	<p>Participate constantly</p>	<p>Invest time</p>
<p>Concentrate on concepts in addition to calculations</p>	<p>Seek help when needed</p>	<p>Eliminate Virtual Distractions</p>