MATH 218 SECTION 3: FALL 2019 SYLLABUS

Note: *the syllabus and course schedule are subject to change. Any changes to the syllabus and/or course schedule after the semester begins will be relayed to the students in class and through email.*

Instructor:	Joe Rabinoff
Email:	`jdr@math.duke.edu`
Office:	Math & Physics 243
Lecture Time:	TTh 1:25–2:40pm
Lecture Location:	Math & Physics 128
Rabinoffice Hours:	Monday, 3–4pm; Friday, 1–3pm; and by appointment
Textbook:	*Introduction to Linear Algebra* (5th Ed) by Gilbert Strang, Wellesley–Cambridge Press/SIAM (2016)
Course website:	`https://services.math.duke.edu/~jdr/1920f-218/`

Description

This is an introductory course on linear algebra that will focus on concepts, methods and applications. Gaussian elimination is presented as the fundamental process for solving systems of linear equations. Deeper understanding is developed by examination of matrix factorizations, orthogonality, and associated vector subspaces. Least squares problems, eigenvalue problems, the singular value decomposition and principal component analysis will also be studied as fundamental tools for solving data-driven applications.

This course will be more applied and computational than *Math 221* (for students heading to a math major), which goes into much more depth on theory and develops skills in writing rigorous mathematical proofs. Math 218 is also significantly different from *Math 216*—less differential equations will be covered; instead, we will treat more advanced topics from linear algebra.

Organization

Attendance is mandatory and vital for success in this class. If you must miss class, you are responsible for catching up on the material.

Homework will be assigned weekly and posted on the web page above. All homework will be submitted and graded on **Gradescope**. You will need to take photos of your homework or scan it in. I recommend Scannable on iOS or Genius Scan on Android.

There will be three in-class **midterm exams**. Each exam will focus on the material covered after the previous exam, but due to the cumulative nature of the material, you will be responsible for knowing all of the material covered up to that point. Calculators may be used for arithmetic purposes only.

The **final exam** will cover all course materials, except those specifically excluded in class. Calculators may be used for arithmetic purposes only.

Most **course materials** will appear on the course website. I will use **Sakai** for the gradebook and for announcements.

Grades for class work will be weighted as follows:

25% Homework 15% Midterm 1 15% Midterm 2 15% Midterm 3 30% Final exam

Cutoffs for letter grades will be determined at the end of the semester, subject to the following guarantee: a final score of 90% or above will merit at least an A-; 80% or above is at least a B-, etc.

Lab

Math 218 has an optional 0.5 credit lab component, Math 218L. In this lab, which meets twice a week, we will cover programming techniques and implement a wide variety of linear algebra algorithms. Later, we will apply them to varied concepts such as machine learning, handwriting recognition, image compression, and others. We will end the semester by implementing a facial recognition algorithm. Code will be developed in Python using the NumPy package. We will explore algorithms, numerical implementations and their difficulties, and develop a substantial code base to use in applications. The workload won't be too large, especially as most work will be carried out in pairs. If you are planning to work in the field of data-based research or data science, the labs will give you a very strong introduction to ideas commonly used in those fields, as well as providing a gateway to more advanced courses.

I highly recommend attending the lab component for a real hands-on learning experience.

Course Schedule

The following is an approximate outline of topics covered, their order, and their timing, along with the relevant chapters in Strang. All of these are subject to modification as the semester progresses.

Introduction: Matrices, Vectors, and Equations — **Chapters 1, 2**, **Weeks 1–3**

- Algebra with vectors
- Algebra with matrices
- Row- and column-based descriptions of systems of equations
- Gaussian elimination
- Inverse matrices
- The LU matrix factorization

Subspaces — **Chapters 3, 4**, **Weeks 4–7**

- Column space and null space of a matrix; dimension
- Orthogonality and projections; orthogonal bases
- Least squares problems
- The Gram–Schmidt process and the QR factorization

Eigenvalues and Eigenvectors — **Chapters 5, 6**, **Weeks 8–11**

- Determinants
- Computing eigenvalues and eigenvectors
- Diagonalization
- Symmetric and positive-definite matrices

The Singular Value Decomposition — **Chapter 7**, **Weeks 12–14**

- Relation to eigenvalues
- Computing the SVD matrix factorization
- Principal component analysis: a brief introduction

The exams are scheduled for the following dates:

Midterm 1: Thursday, September 26
Midterm 2: Thursday, October 24
Midterm 3: Thursday, December 5

The final will take place on Saturday, December 14, 2–5pm.

Make your travel plans accordingly.

Policies

Late homework will generally not be accepted, as I will post solutions shortly after the homework is due. Students may be excused from a missed homework assignment on a case-by-case basis.

I will not hold **make-up midterms.** If you must miss a midterm and have an official excuse (University business, illness, and things of that nature—personal travel does not count), then you will be excused from that exam and the others will be weighted more heavily.

Collaboration on homework assignments is encouraged: please work in groups! However, all students must write up their own work, in their own words. Collaboration of any kind on exams is strictly prohibited; suspected instances will result in a referral to the Office of Student Conduct. Please refer to the Duke Community Standard.