

Mathematics 24
Linear Algebra
Spring 2022
Tentative Syllabus 3/16/2022

Instructor: M. Groszek
Distributive: QDS
Prerequisites: Math 8 or equivalent

This course is an introduction to the fundamental concepts of linear algebra in abstract vector spaces. Linear algebra is a beautiful subject in its own right. It also has applications in many areas, including but not limited to mathematics, physical and biological science, and economics.

This course differs from Math 22, Linear Algebra with Applications, in putting less emphasis on specific applications and more emphasis on mathematical abstraction and theory. In addition to learning linear algebra, students will develop their skills in reading mathematics and in writing proofs.

Math 24 can generally be substituted for Math 22 as a prerequisite for any course or program, although Math 22 may be preferred as preparation for some applied mathematics courses, and Math 24 as preparation for some abstract mathematics courses.

Learning objectives:

Students will be able to use the language and basic notions of linear algebra in reading textbooks, solving problems, and writing proofs, in this and in subsequent courses.

Students will be able to read an introductory undergraduate mathematics textbook with understanding. This does not mean understanding everything immediately. It means being able to figure things out, either on your own or by asking appropriate questions.

Students will be able to write clear and correct proofs. This entails using, and communicating, valid logical reasoning.

Students will know the important theorems and definitions of linear algebra, will be able to state them correctly, and will be able to use them in solving problems and writing proofs. Writing proofs means that students will be able both to figure out how to prove things, at a level of difficulty appropriate to an introductory mathematics course, and to communicate their arguments.

Textbook: *Linear Algebra* 5th edition, Friedberg, Insel and Spence.

Pearson, 2018. ISBN: 978-0134860244

Classes: 2 period (MWF 2:10-3:15, x-hour Th 1:20-2:10), Kemeny 108.

We will meet during some x-hours, for example, to work on proof writing. These meetings will be optional, unless we need to use the x-hour to replace an unexpectedly canceled class.

Instructor: M. Groszek

Office: 330 Kemeny Hall

Email: marcia.groszek@dartmouth.edu

Office hours: TBA

Grading (tentative):

Homework: 20%

Exam 1: 25%

Exam 2: 25%

Exam 3: 30%

Homework: There will be three kinds of homework, all submitted on Canvas.

Reading homework will be due each class day, and will have a written component due the previous night, graded credit or no credit. If you do the assignment you will get credit.

Proof-writing homework will be due most Mondays, and will be graded credit or no credit. If you do not get credit, you will have a chance to redo the assignment for credit.

Regular homework will be due every Monday. Each problem will be graded for both correctness and clarity, on a scale of 0-5.

Late homework will get partial credit. (More details later.) The lowest three reading homework grades will be dropped.

There will be a homework policy document with more details.

Exams: There will be an exam in week 4 on the material covered in weeks 1-3, an exam in week 7 on the material covered in weeks 4-6, and a cumulative final exam concentrating on the material covered in weeks 7-9.

Each exam will have an in-class quiz portion and a take-home exam portion. The quiz portion will not be given during class time, but at a time to be determined. You will be able to take as much time as you need.

The Honor Principle:

Academic integrity is at the core of our mission as mathematicians and educators, and we take it very seriously. We also believe in working and learning together.

The Honor Principle (Homework):

Collaboration is permitted and encouraged, but no copying, and to be clear, this means no copying even from a board or scrap of paper on which a solution was hashed out collaboratively. What a student turns in as a homework solution is to be his or her own understanding of how to do the problems. The solutions you submit must be written by you alone. Any copying (electronic or otherwise) of another person's solutions, in whole or in part, is a violation of the Academic Honor Code.

Moreover, if in working with someone they have provided you with an important idea or approach, they should be explicitly given credit in your writeup. Hints given in office hours need not be cited. It is not necessarily sufficient to annotate your paper with a phrase like "I worked with Lee on all the problems." Individual ideas are to be credited at each instance; they represent intellectual property. Giving another person credit for an idea will never lower your grade. You get credit for your understanding no matter how you acquired it.

The Honor Principle (Exams):

On in-class quiz sections of exams, you may not receive assistance of any kind from any source (living, published, electronic, etc), except the professor, you may not consult any written materials including your notes and textbook, and you may not give assistance to anyone.

On take-home sections of exams, you may use your textbook, your own notes and homework, and any materials distributed in class, but you may not receive help from any other person, and you may not use outside sources, including but not limited to other textbooks and online sources. Matters of clarification are to be left to the professor. If you have any questions as to whether some action would be acceptable under the Academic Honor Code, please speak to me, and I will be glad to help clarify things. It is always easier to ask beforehand.

Disability Accommodations, Religious Observances, and Other Concerns:

The following policies address some common concerns students may have, but certainly not all of them. If you have any questions or worries about the

course or your participation in it, please talk to your instructor. We want all students to succeed.

- Students with disabilities who may need disability-related academic adjustments and services for this course are encouraged to see their instructor privately as early in the term as possible. Students requiring disability-related academic adjustments and services must consult the Student Accessibility Services office (Carson Hall, Suite 125, 646-9900, Student.Accessibility.Services@Dartmouth.edu).

Once SAS has authorized services, students must show the originally signed SAS Services and Consent Form and/or a letter on SAS letterhead to their instructor. As a first step, if you have questions about whether you qualify to receive academic adjustments and services, you should contact the SAS office. All inquiries and discussions will remain confidential.

- The academic environment at Dartmouth is challenging, our terms are intensive, and classes are not the only demanding part of your life. There are a number of resources available to you on campus to support your wellness, including your undergraduate dean, Counseling and Human Development, and the Student Wellness Center.

- The Sexual Respect Website (<https://sexual-respect.dartmouth.edu>) at Dartmouth provides a wealth of information on your rights with regard to sexual respect and resources that are available to all in our community.

Please note that, as a faculty member, I am obligated to share disclosures regarding conduct under Title IX with Dartmouth's Title IX Coordinator. Confidential resources are also available, and include licensed medical or counseling professionals (e.g., a licensed psychologist), staff members of organizations recognized as rape crisis centers under state law (such as WISE), and ordained clergy (see https://dartgo.org/titleix_resources) .

Should you have any questions, please feel free to contact Dartmouth's Title IX Coordinator or the Deputy Title IX Coordinator for the Guarini School. Their contact information can be found on the sexual respect website at: <https://sexual-respect.dartmouth.edu> .

- Some students may wish to take part in religious observances that occur during this academic term. If you have a religious observance that conflicts with your participation in the course, please meet with your instructor before the end of the second week of the term to discuss appropriate accommodations.

- It may be possible to accommodate conflicts with extracurricular activ-

ities, employment, or family responsibilities, although this is not guaranteed. Please meet with your instructor as soon as possible.

This class is planned to be in-person. If circumstances require some classes be held remotely, the following policies are particularly relevant.

Classes, privacy, and intellectual property:

By enrolling in this course, you accept and agree to the College's Consent to Record Statement that follows this short discussion.

Only the instructor may record any Math 19 meetings, including class sessions, breakout rooms, x-hours, and office hours.

I do not intend to record any classes. If I do make any recordings, it will be announced at the time. I will not record office hours.

Please do not share any recordings beyond our class, and do not invite anyone else to observe our Zoom class sessions. Students participating in class should expect that class proceedings are not made public beyond those with legitimate access.

Consent to Record Statement:

(1) Consent to recording of course meetings and office hours that are open to multiple students.

By enrolling in this course,

a) I affirm my understanding that the instructor may record meetings of this course and any associated meetings open to multiple students and the instructor, including but not limited to scheduled and ad hoc office hours and other consultations, within any digital platform, including those used to offer remote instruction for this course.

b) I further affirm that the instructor owns the copyright to their instructional materials, of which these recordings constitute a part, and my distribution of any of these recordings in whole or in part to any person or entity other than other members of the class without prior written consent of the instructor may be subject to discipline by Dartmouth up to and including separation from Dartmouth.

(2) Requirement of consent to one-on-one recordings

By enrolling in this course, I hereby affirm that I will not make a recording in any medium of any one-on-one meeting with the instructor or another member of the class or group of members of the class without obtaining the prior written consent of all those participating, and I understand that

if I violate this prohibition, I will be subject to discipline by Dartmouth up to and including separation from Dartmouth, as well as any other civil or criminal penalties under applicable law. I understand that an exception to this consent applies to accommodations approved by SAS for a student's disability, and that one or more students in a class may record class lectures, discussions, lab sessions, and review sessions and take pictures of essential information, and/or be provided class notes for personal study use only.

If you have questions, please contact the Office of the Dean of the Faculty of Arts and Sciences.

Math 24 Spring 2022
Tentative Schedule

1. March 28-April 1

- (a) Monday: Introduction.
- (b) Wednesday: Vector Spaces.
Sections 1.1, 1.2.
- (c) Thursday (x-hour): Proof-writing workshop.
- (d) Friday: Subspaces.
Section 1.3.

2. April 4-8

- (a) Monday: Linear Equations.
Section 1.4.
- (b) Wednesday: Linear Dependence.
Section 1.5.
- (c) Thursday (x-hour): Proof-writing workshop.
- (d) Friday: Bases and Dimension
Section 1.6

3. April 11-15

- (a) Monday: Chapter 1 Overview.
- (b) Wednesday: Linear Transformations.
Section 2.1.
- (c) Thursday (x-hour): TBA.
- (d) Friday: Matrices and Linear Transformations.
Section 2.2.

4. April 18-22

Exam this week on material covered in weeks 1-3.

- (a) Monday: Composition of Linear Transformations.
Section 2.3.
- (b) Wednesday: Isomorphisms
Section 2.4.
- (c) Thursday (x-hour): TBA.
- (d) Friday: Change of Coordinates.
Section 2.5.

5. April 25-29

- (a) Monday: Matrices.
Section 2.1.
- (b) Wednesday: Rank of a Matrix.
Section 3.2.
- (c) Thursday (x-hour): TBA.
- (d) Friday: Systems of Linear Equations.
Section 3.3

6. May 2-6

- (a) Monday: Systems of Linear Equations.
Section 3.4.
- (b) Wednesday: Determinants.
Sections 4.1-4.2.
- (c) Thursday (x-hour): TBA.
- (d) Friday: Determinants.
Sections 4.3-4.4.

7. May 9-13

Exam this week on material in weeks 1-6 (mostly weeks 4-6).

- (a) Monday: Eigenvalues and Eigenvectors.
Section 5.1

- (b) Wednesday: Diagonalizability.
Section 5.2.
- (c) Thursday (x-hour): TBA.
- (d) Friday: Inner products and Norms.
Section 6.1.

8. May 16-20

- (a) Monday: Inner Products and Norms.
Section 6.1.
- (b) Wednesday: Gram-Schmidt Orthogonalization.
Section 6.2.
- (c) Thursday (x-hour): TBA.
- (d) Friday: Adjoints.
Section 6.3.

9. May 23-27

- (a) Monday: Normal and Self-Adjoint Operators.
Section 6.4.
- (b) Wednesday: Spectral Theorem.
Sections 6.5-6.5.
- (c) Thursday (x-hour): TBA.
- (d) Friday: Cayley-Hamilton Theorem.
Section 5.4.

10. May 30-June 3

- (a) Monday: No class; Memorial Day.
- (b) Tuesday (x-hour): No x-hour today.
- (c) Wednesday: Conclusion.
Last day of class.

11. Exam during finals period, cumulative, concentrating on material in weeks 7-9.