

# Syllabus for Math 416 Abstract Linear Algebra

## General information

- **Instructor:** Daesung Kim (daesungk@illinois.edu), 247B Illini Hall
- **Office Hour:** Mon 11am–12pm, Thu 2–3pm, and by appointment
- **Section:** B13 (CRN: 54464)
- **Time and place:** MWF 9:00-9:50, 347 Altgeld Hall
- **Course webpage:** <https://daesungk.github.io/teaching.html>
- **Prerequisites:** Math 241 and Math 347 (strongly recommended)
- **Grader:** Qihang Sun (qihangs2@illinois.edu)
- **Textbook:** [FIS] *Linear Algebra*, 4th edition, by S. H. Friedberg, A. J. Insel and L. E. Spence.
- **Supplementary text:** [Bee] *A First Course in Linear Algebra*, Version 3.5 (2015), by R. A. Breezer (it is free and available online).
  - Online version: <http://linear.ups.edu/html/fcla.html>
  - PDF version: <http://linear.ups.edu/download.html>

## Description

Math 416 is a rigorous, abstract treatment of linear algebra. Topics to be covered include vector spaces, linear transformations, eigenvalues and eigenvectors, diagonalizability, and inner product spaces. The course concludes with a brief introduction to the theory of canonical forms for matrices and linear transformations.

## Weekly Homework

- 11 Homework assignments will be given.
- The assignment schedule can be found in the course schedule.
- Homework will be collected at the beginning of the class.
- Late homework will not be accepted.
- The lowest two homework grades will be dropped.

## Exam

- **In-class midterms:** Three 50 minute exams will be held in our usual classroom (347 Altgeld Hall) on the following date: Sep 25, Oct 23, and Nov 20.
- **Final exam:** The combined final exam will be held on Dec 18. The place will be announced later.
- **Missed exams:** There will be no make-up exams. In the event of a valid illness, accident, or family crisis, you can request to be excused from an exam so that it does not count toward your overall average. All such requests should be made in advance.

## Policy

- **Overall grading:** Weekly homeworks (15%), three in-class midterm exams (15% each), and a comprehensive final exam (40%).
- **Cheating:** Cheating is taken very seriously. Penalties for cheating on exams, in particular, are very high, typically resulting in a 0 on the exam or an F in the class.
- **Disabilities:** Students with disabilities who require reasonable accommodations should see me as soon as possible. In particular, any accommodation on exams must be requested at least a week in advance and will require a letter from DRES.

## Schedule

(This is a tentative version. Update will be posted in the course webpage.)

### Week 1

- 8/26: Introduction. Section 1.1 of [FIS].
- 8/28: Vectors spaces. Section 1.2 of [FIS].
- 8/30: Subspaces. Section 1.3 of [FIS]. HW 1 (Due 9/6).

### Week 2

- 9/2: Labor Day. No class.
- 9/4: Linear combinations and systems of linear equations. Section 1.4 of [FIS] and Section SSLE of [Bee].
- 9/6: Using matrices to encode and solve linear systems. Section RREF of [Bee]. HW 2 (Due 9/13).

### Week 3

- 9/9: Row echelon form and Gaussian elimination. Section RREF of [Bee].
- 9/11: Solution spaces to linear systems. Section TSS of [Bee].
- 9/13: Linear dependence and independence. Section 1.5 of [FIS]. HW 3 (Due 9/20).

### Week 4

- 9/16: Bases and dimension, part 1. Section 1.6 of [FIS].
- 9/18: Bases and dimension, part 2. Section 1.6 of [FIS].
- 9/20: Bases and dimension, part 3. Section 1.6 of [FIS].

### Week 5

- 9/23: Linear transformations. Section 2.1 of [FIS].
- 9/25: Midterm 1.
- 9/27: The dimension theorem. Section 2.1 of [FIS]. HW 4 (due 10/4).

### Week 6

- 9/30: The matrix representation of a linear transformation. Section 2.2 of [FIS].
- 10/2: Composition of linear transformations and matrix multiplication, part 1. Section 2.3 of [FIS].
- 10/4: Composition of linear transformations and matrix multiplication, part 2. Section 2.3 of [FIS]. HW 5 (Due 10/11).

### Week 7

- 10/7: Invertibility and isomorphisms. Section 2.4 of [FIS].
- 10/9: Matrices: invertibility and rank. Section 2.4 of [FIS] and Sections MINM and CRS of [Bee].
- 10/11: The change of coordinate matrix. Section 2.5 of [FIS]. HW 6 (Due 10/18).

### Week 8

- 10/14: Intro to determinants. Section 4.1 of [FIS].
- 10/16: Definition of determinants. Section 4.2 of [FIS].
- 10/18: Determinants and row operations. Section 4.2 of [FIS].

### Week 9

- 10/21: Properties of determinants, part 1. Sections 3.1 and 4.3 of [FIS].
- 10/23: Midterm 2.
- 10/25: Properties of determinants, part 2. Section 4.3 of [FIS]. HW 7 (Due 11/1).

### Week 10

- 10/28: Diagonalization and eigenvectors. Section 5.1 of [FIS].

- **10/30:** Finding eigenvectors. Sections 5.1 and 5.2 of [FIS].
- **11/1:** Diagonalizability, part 1. Section 5.2 of [FIS]. HW 8 (Due 11/8).

## Week 11

- **11/4:** Diagonalizability, part 2. Section 5.2 of [FIS].
- **11/6:** Intro to Markov Chains. Section 5.3 of [FIS].
- **11/8:** Convergence of Markov Chains. Section 5.3 of [FIS]. HW 9 (Due 11/15).

## Week 12

- **11/11:** Inner products and norms. Section 6.1 of [FIS].
- **11/13:** Inner products and orthogonality. Sections 6.1 and 6.2 of [FIS].
- **11/15:** Gram-Schmidt orthogonalization process. Section 6.2 of [FIS].

## Week 13

- **11/18:** Orthogonal complements and projections. Sections 6.2 and 6.3 of [FIS].
- **11/20:** Midterm 3.
- **11/22:** Projections and adjoints. Section 6.3 of [FIS]. HW 10 (Due 12/4).

## Week 14: Fall Break

## Week 15

- **12/2:** Normal and self-adjoint operators, part 1. Section 6.4 of [FIS].
- **12/4:** Normal and self-adjoint operators, part 2. Section 6.4 of [FIS]. HW 11 (Due 12/11).
- **12/6:** Orthogonal and unitary operators and their matrices. Section 6.5 of [FIS].

## Week 16

- **12/9:** The singular value decomposition. Section 6.7 of [FIS].
- **12/11:** The Jordan canonical form. Section 7.1 of [FIS].

Final Exam: 1:30–4:30pm, Wednesday, Dec 18. Place will be announced later.