

**MATHEMATICS 355**  
**ADVANCED LINEAR ALGEBRA, SPRING 2009**

**Textbook:** *Linear Algebra* by Friedberg, Insel, Spence, 4th edition

**Weekly schedule:** MTThF 10:30 - 11:20 am

**Instructor:** Chris Moseley, NH 286

**Email:** cgm3@calvin.edu

**Office hours:** 12:30 - 1:20 pm, M - F, or by appointment

**Website:** [www.calvin.edu/~cgm3](http://www.calvin.edu/~cgm3)

**What this course is about:** linear algebra is the study of *vector spaces* and mappings between vector spaces (*linear transformations*). This course is designed for students of mathematics and other disciplines who need a rigorous foundation in linear algebra. It assumes that students are already familiar with the elementary tools and ideas of linear algebra such as matrix multiplication, the rank and nullspace of a matrix, eigenvectors and eigenvalues, to name a few (see **Prerequisites**). The assigned problems in this course will usually go beyond mere computational exercises and will often involve proving mathematical propositions.

**Prerequisites:** the standard prerequisites for this course are Mathematics 256, or Mathematics 232, or both Mathematics 231 and 261. Exceptions may be granted by the instructor, but all students should be familiar with the elementary ideas and tools of linear algebra that are covered in these courses.

**List of topics:** (tentative)

- 1.1 Introduction
- 1.2 Vector Spaces
- 1.3 Subspaces
- 1.4 Linear Combinations and Systems of Equations
- 1.5 Linear Dependence and Linear Independence
- 1.6 Bases and Dimension
  
- 2.1 Linear Transformations, Null Spaces, and Ranges
- 2.2 The Matrix Representation of a Linear Transformation
- 2.3 Composition of Linear Transformations and Matrix Multiplication
- 2.4 Invertibility and Isomorphisms
- 2.5 The Change of Coordinate Matrix
- 2.6 Dual Spaces
- 2.7 Homogeneous Linear Differential Equations with Constant Coefficients
  
- 3.1 Elementary Matrix Operations and Elementary Matrices
- 3.2 The Rank of a Matrix and Matrix Inverses

### 3.3 Systems of Linear Equations—Theoretical Aspects

#### 4.1 Determinants of Order 2

#### 4.2 Determinants of Order $n$

#### 4.3 Properties of Determinants

#### 4.4 Summary—Important Facts about Determinants

#### 5.1 Eigenvalues and Eigenvectors

#### 5.2 Diagonalizability

#### 5.3 Matrix Limits

#### 5.4 Invariant Subspaces and the Cayley-Hamilton Theorem

#### 6.1 Inner Products and Norms

#### 6.2 The Gram-Schmidt Orthogonalization Process and Orthogonal Complements

#### 6.3 The Adjoint of a Linear Operator

#### 6.4 Normal and Self-adjoint Operators

#### 6.5 Unitary and Orthogonal operators and Their Matrices

#### 6.6 Orthogonal Projections and the Spectral Theorem

#### 6.7 The Singular Value Decomposition and the Pseudoinverse

#### 6.8 Bilinear and Quadratic Forms

#### 6.11 The Geometry of Orthogonal Operators

#### 7.1 The Jordan Canonical Form, I

#### 7.2 The Jordan Canonical Form, II

Other topics, such as tensor products of linear operators, may be covered if time permits.

**Grading:** Your grade will be determined by your performance on homework and other written work, hour tests, and the final exam. The contributions for each category are:

- Homework, etc.: 20%
- Tests: 45%
- Final exam: 35%

**Normal grade scale:** A numerical grade of 90 or above will usually receive at least an A-; a grade of 80 or above, at least a B-; and so on.

**Homework, etc.:** Homework will generally be assigned each class period. Normally, homework assigned on Mondays and Tuesdays will be due by the start of class on Thursday and homework assigned on Thursdays and Fridays will be due by the start of class on Tuesday. Homework will be accepted one collecting period late, but will be penalized 30%. Homework more than one collecting period late will normally receive no credit. **You may discuss homework problems with other students, but the written solutions must be your own work and not a copy of another student's work.**

**Homework standards:** Homework submissions comprising more than one sheet of paper *must be stapled*. Your written work should be neat, organized and professional. Spelling and grammar errors may result in points being deducted. When an assigned problem involves writing a proof, your solution will be graded with regard to both the logical validity of your argument and the clarity of its presentation.

**Tests:** There will be no makeup tests. If you have to miss a test for some reason, then the grade you get on the final exam will be used as your grade for that test.

**Students with documented disabilities** may arrange to take the test in a different location but at the same time as the rest of the class. Please see me at least two days ahead if you wish to arrange for a separate location.

**Final exam:** The final exam will be comprehensive, and will be based on material covered in class and the textbook. The final exam will be given on **Monday, May 18 at 1:30 pm in this classroom**. Make sure to arrange your schedule in such a way that you have no examination conflicts.

**Computer algebra systems:** At times we will make use of a computer algebra system (CAS) to handle larger calculations. You are free to use your favorite CAS. *Maple* and *Mathematica* are well suited for our course. *Mathematica* is installed on the computers in the Mathematics Department Computer Lab, and student pricing is available for both *Maple* and *Mathematica* should you decide to purchase your own CAS.

**Academic Integrity:** In general, you may discuss homework problems with other students, but the written solutions you submit must be your own work and not simply a copy of another student's work. There may be special problems assigned for which no collaboration with others is allowed. It will be made clear if collaboration is not allowed on an assigned problem. Of course, cheating on tests or the final exam is not allowed. Cheating includes the use of unauthorized notes or devices, copying from another student, or consciously allowing another student to copy from your work. Details of Calvin's policy on academic integrity can be found in the College's Student Conduct Code:

<http://www.calvin.edu/student-life/forms-policies/pdf/student-conduct.pdf>

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