

MATH 416, SPRING 2010

1. COURSE CONTENT

Math 416, *Abstract Linear Algebra*, is an introduction to linear algebra with a focus on proof. The course begins by investigating techniques for solving systems of linear equations, in turn paving the way for an abstraction to matrices and matrix operations. Exploring the properties of matrices will translate our initial algebraic questions into geometric ones, a dictionary which will ultimately provide most of the interesting applications in the subject. Whereas many linear algebra courses place an emphasis on computational proficiency and give short shrift to concepts, this course will attempt to strike a richer balance, one in which computations and “real” examples provide the groundwork for a more general, abstract theory.

Though we will move towards abstraction, the concepts we will focus on are borne from concrete examples. Students who hold on to a geometric understanding of the material should find the topics we cover quite natural and easy to remember. That said, our emphasis on proof in the course means that students will need to keep up with the new terminology and theorems presented in class. You will find that the course requires you to learn a new language, and you will not be able to succeed unless you spend time learning its vocabulary and syntax.

Specific topics which will be covered include, but are not necessarily limited to: solutions to systems of linear equations, Gaussian elimination, matrix algebra, vectors and their properties, linear transformations, abstract vector spaces, dimension theory, the Gram-Schmidt algorithm, least squares, eigenvalues and eigenvectors, discrete and continuous dynamical systems, the singular value decomposition, and stochastic matrices.

2. COURSE DETAILS

2.1. Instructor. The instructor for this class is Andrew Schultz. His office is in Illini Hall, room 238. He is readily available by email at acs@math.uiuc.edu. His office hours are Mondays and Wednesdays from noon to 1, though you can schedule additional meeting times if you cannot make these times.

2.2. Time and Location. The course will be held on Tuesdays and Thursdays from 9:30 to 10:50 in room 341 of Altgeld Hall.

2.3. Text. The course is centered around the 4th edition of Bretscher’s *Linear Algebra with Applications*. Homework assignments will be taken primarily from this book, so students should have a copy of the text for the course. I don’t know if older versions of this text have the same homework problems; if you have an older copy of the text, it is your responsibility to make sure you are doing the correct assignment.

3. EXPECTATIONS

3.1. Prerequisites. Students are expected to have a solid understanding of standard, high school-level algebra and trigonometry. Students should also be familiar enough with differential and integral calculus that they can easily perform standard computations. Ideally you will already have taken a class on proof techniques, but this

is not essential. If you have not taken Math 347, though, you will be expected to pick up proof techniques as they are used in class; if you're having trouble doing so, be sure to let the instructor know.

3.2. In-class expectations. A student's engaged presence is expected in classroom lectures. While the professor is in charge of determining what content is covered during a class period, students share the responsibility of directing lectures so each is as clear as possible. In particular students should feel comfortable stopping the professor to repeat a particular exposition, to present a concrete example of an abstract concept, or to explain a confusing concept in a new way. Classroom time is there for the benefit of students, so should be treated as an interactive resource.

3.3. Assignments. Mathematics cannot be learned without a large amount of personal effort, so this course will have a number of written assignments to solidify your understanding of the material and to provide the professor a gauge with which to assess your understanding. Students are expected to work diligently, thoughtfully, and cleanly when completing assignments. Homework assignments will be assigned for each class period. It is imperative that homework solutions be written neatly, both for the sake of the grader and the student. Treating homework seriously is a student's best preparation for quizzes and tests, and hence the best way for a student to score well in the class.

4. GRADING

4.1. Homework. At the beginning of class, students will submit their homework assignments. Students who are not in class on time will not be allowed to submit their homework assignment late. The professor will then call on students to present their solutions to particular problems on the board. Each student is responsible for regularly presenting solutions to the class, and therefore should be prepared each and every class day to discuss his/her solutions with the rest of the class.

It is suggested that students observe the following guidelines when writing their homework solutions. First, a student should work out each problem on scratch paper. After a solution has been determined for a problem, a complete solution—without excessive erasures—should be copied on the front side of a clean sheet of paper. Solutions should include more than just mathematical symbols; they should also contain phrases which explain what is happening or being checked in a particular computation. Standard mathematical conventions should be observed while writing solutions. For example, one should not use an equal sign to mean 'implies.' Handwriting should be more than legible, and one should not try to fit too many things on a single line or piece of paper. It is fine to write solutions to multiple problems on a single sheet of paper, provided that ample space has been provided between each problem. Homework papers should not have ragged edges. A student's solution set should be stapled if it contains more than one sheet of paper. The grader will deduct points from solutions sets which are messy or illegible.

Students are welcomed to talk to the instructor or each other in order to solve homework problems, but *each student must write up his or her own solutions without the benefit of notes from discussions with the instructor, course assistant, or other students.* While writing solution sets you are welcome to look at scratch work that you have completed on your own, but any work you have completed with the help of another person should first be recreated by yourself—without notes—before you use it as a reference in writing solutions.

There will be one homework assignment due each day, with the exception of days of exams. Homework will be due five minutes after the beginning of class, and late homework is not accepted. If you must miss class on a day that an assignment is due, it is your responsibility to hand your homework in before the beginning of the class period in which the assignment is due. Your homework grade is determined by averaging all your homework grades from the term.

4.2. **Quizzes.** There will be one in-class, timed quiz per week, except for the first week of class and on those weeks when you have an exam. Quizzes will last 10-15 minutes and are given on Thursdays. Calculators may not be used on quizzes. Quizzes test the material covered in the week's homework assignment as well as important definitions and concepts from class. Your quiz average is computed by averaging all your quiz grades.

4.3. **Tests.** There will be 2 midterm examinations and 1 final. The first midterm will be held during class on Thursday, February 25, and your second midterm will be held during class on Thursday, April 8. Since the exams are held during class, no students should have conflicts which prevent them from taking the exam during the scheduled time. Make sure you see the professor as soon as you know about any potential conflict. Do not make plans to miss an exam before the professor has approved your conflict! If you make plans that conflict with an exam without consulting the professor, and if the conflict is not approved, you will not be allowed to retake the exam. Your final will be held on Monday, May 10 at 8am.

4.4. **Attendance.** More than any other discipline, mathematics requires that a student understand one concept before moving on to the next. Therefore it is critical that you attend this class on a regular basis in order to stay on track with the material we cover. Students with excessive absences will see their grade diminished. More than 3 unexcused absences over the course of the term will be considered excessive.

4.5. **Computing your grade.** Your grade is computed as follows:

• Midterm 1	20%
• Midterm 2	20%
• Quiz Average	20%
• Homework Average	15%
• Final	25%

5. RESOURCES

5.1. **Office Hours.** Students are highly encouraged to attend office hours to discuss concepts covered in class or ask questions about homework assignments. There are several office hours per week for this class.

5.2. **Text.** In addition to have lots of problems to help you work through new concepts, your text also provides another source of understanding the course material.

5.3. **Course Webpage and Course Notes.** Homework assignments and practice exams, together with solutions, will be posted at the course webpage <http://www.math.uiuc.edu/~aschultz/w10/math416>. Course notes for the lectures will also be posted; these will cover the material discussed in lecture and should be posted by the end of each lecture day.

5.4. **Your classmates.** Discussing problems with classmates is a great way to hear new ideas for attacking problems. Remember, though, that students must write up homework assignments on their own.