Math 334: Linear Algebra, Second Course
Northwestern University, Summer 2015

Course Information

- Instructor: Santiago Cañez
- Email: scanez@northwestern.edu
- Website: https://canvas.northwestern.edu/courses/21108/
- Office Hours: TTh 3-5pm in Lunt B27, or by appointment
- Lecture: TTh 7-9pm in Lunt 107
- Textbook: *Linear Algebra Done Right, 3rd ed.* by Axler
- Prerequisites: Math 240 or a similar linear algebra course, Math 300 or instructor consent

Topics Covered

Vector spaces and subspaces, Linear maps and operators, Invariant subspaces, Inner products and adjoints, Spectral Theorem, Generalized eigenspaces and Jordan form

What Is This Course About?

Linear algebra is the study of vector spaces and linear maps between them. This subject arose from the study of systems of linear equations and their geometric aspects. It has become a cornerstone of modern mathematics, with applications in a wide variety of areas. The reason is that compared to other areas of mathematics, linear algebra is "easy" — not in the sense that the material is easier to understand, but simply in the sense that we understand it a whole lot better. Because of this, it is often useful to take questions arising in other areas and turn them into questions about linear algebra. This turns out to be an extremely fruitful idea.

Our first main goal will be to become acquainted with the language and tools of linear algebra. To do so, we will be working with abstract vector spaces and linear transformations. In a previous linear algebra course you would have focused mainly on matrices and the vector space $\mathbb{R}^n$. While matrices have many wonderful computational aspects, in a way they hide the true nature of the mathematics taking place. It is only through a study of abstract vectors spaces and linear maps that we fully see the intuition and depth behind many results in linear algebra. This means that as opposed to the computational problems you saw in a previous course, we will be interested in more theoretical aspects. For example, previously you dealt with questions like: given a matrix, what are its eigenvalues and eigenvectors? Here, the more important question to ask is: What do the eigenvalues and eigenvectors of a linear operator tells us about that operator and the vector space on which it acts? This is the kind of question that makes linear algebra so useful in other areas of mathematics. Hopefully we'll have a chance to briefly look at some applications.

Apart from learning about the abstract theory of vector spaces, a second main goal of this course will be to become yet more familiar with formal mathematical reasoning and writing. You should have seen some of the basic ideas before in Math 300, and here we will continue to work on these proof-writing techniques. When writing a proof, you should imagine that the reader knows nothing of the statement you are trying to prove. Your proof should be viewed as a journey that you and the reader embark upon together. It is your job to lead him/her to the same conclusion you yourself arrived at.

What Should You Already Know?

The official prerequisites for this course are Math 240 and Math 300, or similar courses. In particular, you should have been exposed to matrices and solving systems of linear equations before. If it has been a while since you've taken Math 240 or an equivalent course, you may want to briefly review some of that material. Anything you may have forgotten should be easy enough to pick up again, but ask me if you have concerns about background material. We could possibly review some things in office hours if need be. If you haven't taken a course like Math 300 before, it should not be a major issue since this course will give you plenty of opportunities to learn how to write proofs.

Whereas determinants were essential in Math 240, you will notice that the book does not cover determinants until the end, Indeed, although you should have hopefully seen and computed determinants before, we will not actually cover them in any depth in this course. From time to time, it may be necessary to compute the determinant of some matrix, but your Math 240 knowledge should suffice for that. The problem with using determinants too much in a course like this is that they tend to obscure the real mathematics going on and do not provide much additional insight. Still, you may want to look over this last chapter after the course is over, even though most of it should be familiar from Math 240. Along these lines, you should also have experience finding eigenvalues and eigenvectors of a matrix, although this we will review a bit in class as needed.

Homework, Quizzes, and Exams

There will be weekly homework assignments due on Tuesdays. You are encouraged to work together on problem sets, but each of you must hand in your own work in your own writing. There will also be weekly 10 minute quizzes at the end of class on Thursdays, except for exam days. The quizzes will cover material from the homework handed in the previous Tuesday. Finally, we'll have a midterm on July 23rd and a final on August 13th.

Grades

Your final score will be composed of homework and exam scores according to the following percentages: 30% Homework, 20% Quizzes, 20% Midterm, 30% Final Exam. What constitutes an A, B, etc. will be determined at the end once all scores have been totaled, so there is no set scale. However, I'll try to give a sense of where you stand throughout the quarter.

University Policies

Students are required to abide by Northwestern University's academic integrity policy, which can be found at http://www.northwestern.edu/provost/students/integrity/. Failure to adhere to this policy will likely result in a failing grade in the class and/or expulsion from the University.

Any student requesting accommodations related to a disability or other condition is required to register with AccessibleNU (847-467-5530) and provide professors with an accommodation notification from AccessibleNU, preferably within the first two weeks of class. All information will remain confidential.