

# Math 291-1: Intensive Linear Algebra & Multivariable Calculus

## Northwestern University, Fall 2015

### Course Information

- Instructor: Santiago Cañez
- Email: Email: [scanez@northwestern.edu](mailto:scanez@northwestern.edu)
- Website: <https://canvas.northwestern.edu/courses/22723/>
- Office Hours: M 2-3pm and W 3-4pm in Lunt B27, or by appointment
- Lecture: MWF 12–12:50pm in ???
- Discussion: Th 12–12:50pm in ??? with Eric Dolores-Cuenca, or  
Th 12–12:50pm in ??? with Philip Egger
- Textbook: *Linear Algebra with Applications, 5th ed.* by Bretscher
- Prerequisites: Invitation to join MENU

### Topics Covered

Vectors and linear systems, matrices and linear transformations, vector spaces and subspaces, bases and coordinates, orthogonality, proof writing and techniques

### What Is This Course About?

This year-long sequence is all about linear algebra and multivariable calculus, with this quarter's focus being linear algebra. Linear algebra is, essentially, the study of lines, planes, and other “linear” things. (Roughly, “linear” refers to the fact that these can all be described using equations where each variable only appears to the first power, although we'll see a better definition of “linear” soon enough.) Although this quick description might not seem all that interesting, the real power comes when realizing that so many pieces of information in various fields (pretty much every scientific or engineering field, economics and other social sciences, etc.) can be phrased in terms of such objects, and much of the linear algebra you will learn leads to incredibly diverse applications. Of all the mathematical subjects you will ever encounter, linear algebra is likely to be the most useful, possibly apart from calculus.

As a first approximation, linear algebra deals mainly with vectors and matrices, and indeed most of what we do in this course we'll be phrased in terms of these two concepts. However, we'll see that these are but special instances of the more general notions of *vectors spaces* and *linear transformations*, which is what linear algebra is truly concerned with at a deeper level. Naturally—given the structure of this year-long sequence—you may be wondering just what this all has to do with calculus. The point is that when phrased in the right way, calculus is indeed about replacing possibly complicated nonlinear things with simpler linear ones. After all, what is the derivative of a function at a point but the slope of the corresponding tangent line. Similarly, when moving to functions of more than one variable, instead of tangent lines we have tangent planes, and linear algebra will help to put many of their properties in the right context. Matrices show up all over the place in multivariable calculus, and after having had linear algebra first you will hopefully understand why they do.

We will be proving things in this course, a lot of things. Indeed, this is perhaps the main distinction between Math 291 vs Math 290. The point is that it is only through proof-writing that mathematicians truly learn and understand mathematics. In addition to being tools which

convince others that your mathematical ideas are correct, proofs are also essential to understanding the hidden structure and relations between differential mathematical topics. Learning how to read, understand, and write proofs will be a goal throughout the entire year.

## **What Should You Already Know?**

Officially the only thing with which you should already be familiar is single-variable calculus. We'll use some calculus from time to time, but the main reason having had calculus is useful is to make sure you are "mathematically mature" enough for this course. Above all, the most important quality a successful student in this course should possess is a great deal of motivation and enthusiasm, and a willingness to be challenged and to wrestle with possibly complex ideas.

## **Homework and Exams**

There will be weekly homework assignments, usually due on Fridays. You are encouraged to work together on problem sets, but each of you must hand in your own work in your own writing. Problems on assignments will almost always involve coming up with some type of proof, so a side goal of this course is to develop this skill further. There will also be weekly quizzes held in discussion on Thursdays, and in the end your lowest homework and quiz scores will be dropped.

There will be two midterms and a final exam. The midterms will be held in discussion on October 22nd and November 19th. The final will be held on Thursday, December 10th from 12–2pm. Please see me as soon as possible if you have a conflict.

## **Grades**

Your final score will be composed of homework and exam scores according to the following percentages: 10% Quizzes, 20% Homework, 20% Midterm 1, 20% Midterm 2, 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.