Math 108a | Professor: Padraic Bartlett

Syllabus for Math 108a

Weeks 1-10 | *UCSB 2013*

Basic Course Information

- Professor: Padraic Bartlett.
- Class time/location: MWF 9-9:50, Phelps 3505.
- Office hours/location: TTh 2-3pm, South Hall 6516. Additionally, I am teaching a different linear algebra class (Math/CS 103), whose office hours are on TTh 1-2pm; you are welcome to attend these office hours instead if they work better for you. Finally, if neither of these times work well for you, I can meet students outside of these times by appointment; email me and we'll set something up!
- Homework post date/time: Thursday evening, the week before the set is due.
- Homework due dates: Friday at 1:30pm, in a folder on my office door in 6516 South Hall. Homework will not exist on weeks where tests occur.
- Email: padraic@math.ucsb.edu.
- Course webpage: on GauchoSpace. If GauchoSpace is down, or you are otherwise having difficulty getting access, a second copy of the website can be found here: http://math.ucsb.edu/~padraic/math108a_2013/math108a_2013.html
- TA: Shahab Karimi.
- TA email: shahab@math.ucsb.edu.
- TA office hours/location: South Hall 6431B, Tuesdays 1:30-3:30pm.
- TA Mathlab hours: South Hall 1607, 5-7 Thursdays.

Course Description

Math 108A's description in the college catalog is the following:

> ***Prerequisites**: Mathematics 3C or 3CI or 4A or 4AI, 4B or 4BI or 5A or 5AI; and Math 8 with a grade of "C" or better.*
>
> Abstract vector spaces; subspaces. Span and linear independence. Basis and dimension. Linear maps. Eigenvalues and eigenvectors.

This might seem somewhat confusing; after all, in the linear algebra classes listed as prerequisites for this course, you've **already covered** the topics listed in the course description. So: what is Math 108A?

The answer, as with many things, lies in its name. Math 108a is perhaps best regarded as an overgrown sequel to Math 8: while 108A looks like a linear algebra course on the surface, it's **actually** a course on mathematical thinking and proofs. Over the next ten weeks, we are going to revisit the material of classes like Math 5A from a much more theoretical viewpoint; we will work in general vector spaces instead of just $\mathbb{R}^n$, prove theorems that we've merely used in prior courses, and use this abstraction to study results that were previously inaccessible to us.

Course Evaluation

There are four components of your grade in Math 108A:

- **Homework** (35%.) There will be eight homework sets; they will be due on Thursdays at 3pm in a folder posted on my door in my office in South Hall. Office hours are a particularly good time to drop off said homework. Because there are more than 90 Math 108A students across two sections all being graded by the same TA, and we do not said TA to die, problem set evaluation will be done by picking three problems at random and grading student performance on those three problems.

  Your lowest homework score will be dropped at the end of the quarter. Accordingly, no late homework sets will be accepted, barring ER-level medical emergencies and other such exceptional situations. Should you find yourself in such a situation, please contact me as soon as possible, so we can do our best to help you out.

  When writing up your homework, make sure to clearly state the problem being solved and write down all of the steps involved in arriving at your answer. If you've used things like Mathematica or Wolfram Alpha, simply saying "By Mathematica, the answer is X" will result in losing points; you need to actually go through your work and do a step-by-step outline of how the result is derived. If you are unsure if a step should be written down, a good rule of thumb is the following: Did this step take me more than ten seconds to figure out? If so, it's not entirely obvious, and it should be written. If not, then it may be obvious enough to omit.

  If you still have questions, feel free to email me or the TA, or come to office hours! We are glad to clarify things.

- **Quizlets** (15%). There will be intermittent quizzes throughout the course, on Fridays. They are meant to be a few very simple questions asking people to give simple examples of various concepts, define basic terms, etc.; their purpose is just to check whether or not people are following the basics of the course. Your lowest two quiz scores will be dropped. Accordingly, no make-up quizzes will be given.

- **Exams** (50%.) There will be an in-class midterm on November 1, 10:00-10:50, and a final (location TBA) on December 11, from 8-11am. The midterm will be worth 20% of your final grade, and the final will be worth 30% of your final grade. No make-up

tests will be given, except under truly extraordinary circumstances. If you have a serious conflict with either of these dates, please let me know as soon as possible. If you somehow miss one of these exams, also let me know as soon as possible.

Letter grades for this course are only determined at the end of the semester, based on the overall class performance on the midterm/final/homework/quizzes. That said, any student with a 90% or higher will definitely earn some sort of an A, 80%'s will earn at least some sort of B, and 70%'s will earn no less than a C. It is possible that our curve will be a bit kinder than this. If you are worried about your performance at any point in the course relative to your peers, email me or come to office hours.

Collaboration/resources policy

Collaboration is allowed (and indeed encouraged) on the homework sets; mathematics at the research level is a collaborative activity, and there is no reason that it should not also be this way in a classroom. Work with your classmates!

Similarly, mathematics **is** a research activity; I would claim that banning resources like textbooks, Wikipedia, Mathematica, etc. is something of a fool's errand, and contradictory to the spirit in which we pursue research as professors ourselves.

The only things that we ask of you are the following:

- Write up your work separately, and only write up solutions you understand fully.
- When writing up your own work, the only references you can directly cite are Axler's Linear Algebra Done Right and the online course notes for this class. While you are allowed to look at and read other sources, you can't write things like "by result *blah* in text *foo*, we know that this result holds," unless the text you're referring to is either Axler or my notes. If you come across a result you really like and want to use, you need to prove it on your own problem set (and write up said proof in your own words!)
- Don't post questions to online messageboard-style services.

The tests will have their own resource and collaboration policies, which will be printed on the test.

If you have any questions on the collaboration policy, please email me and I'll be glad to clarify matters.

Course Textbook

The course textbook is Axler's Linear Algebra Done Right, which is recommended but not required. It's one of my favorite books in mathematics; in particular, Axler's writing is some of the clearest and cleanest in the field, and the the order in which he presents material is excellent in a course like ours. Also, it has the virtue of being a paperback you can pick up for less than 25 dollars used on Alibris.

That said, his book has two somewhat glaring faults: (1) it's terse and (2) it doesn't work as many examples as I'd like. As a supplement for students that like lots of examples

and practice problems, a somewhat-decent supplement is Sergei Treil's humorously-named Linear Algebra Done Wrong. This book lacks the proof-oriented emphasis of Axler's book (and is more of a Math 4a text to be honest,) but it may be useful.

All of that said, I intend on typing up all of my lectures in LaTeX, a typesetting mathematical program that you should consider learning to use yourself if you're going to major in mathematics. Notes will be posted on the course webpage as they are typed, within a few days of the lecture given, and will hit most of the same concepts mentioned in lecture itself.

Course Timeline

The following is a rough sketch of the topics we'll cover in Math 108A this term, and the order in which we'll cover them. As with any day-by-day schedule, we're likely to deviate from this plan as the course develops; it's more of a guideline than a rule.

That said, some things are relatively predictable. We will have eight problem sets due throughout the course, as well as eight small quizlets. The quizlets will occur on the days marked with asterisks (basically every Friday, except for when that conflicts with midterms/finals.)

9/27: Introduction; field axioms.

9/30: Examples of fields.

10/2: Vector space axioms and examples.

*10/4: Subspaces of vector spaces.

10/7: Span; linear independence.

10/9: Basis and dimension.

*10/11: Linear maps: definitions, examples.

10/14: Linear maps: more examples.

10/16: Linear maps: null space, range.

*10/18: Injection, surjection, & isomorphism.

10/21: The rank-nullity theorem.

10/23: Linear maps and matrices.

*10/25: Change of basis: maps and matrices.

10/28: Invertible maps and matrices.

10/30: Midterm review session.

11/1: **Midterm.**

11/4: Elementary matrices and operations.

11/6: Elementary matrices and invertibility.

*11/8: Solving systems of linear equations with matrices.

11/11: **Veteran's Day**; no class.

11/13: Polynomials and their roots.

*11/15: Matrix polynomials.

11/18: Eigenstuff: definitions, examples.

11/20: Eigenstuff: existence and nonexistence.

*11/22: Eigenstuff: applications

11/25: Upper-triangular matrices.

11/27: Diagonal matrices.

11/29: **Thanksgiving**; no class.

12/2: The determinant as volume.

*12/4: Properties of the determinant.

12/6: Final review session.

12/9: **Final,** 8-11am.