Math 108a | Professor: Padraic Bartlett

Syllabus for Math 108B

Weeks 1-10 | *UCSB 2014*

Basic Course Information

- Professor: Padraic Bartlett.
- Class time/location: MWF 9-9:50, Psych 1902.
- Office hours/location: Thursdays, 2-3pm, South Hall 6516. Additionally, I have office hours from 1-3pm Tuesday and 1-2pm Thursday for my other three classes; you are welcome to attend these office hours instead if they work better for you, though students from those classes "have priority" during these time slots.
- Homework post dates/times: The weekend the week before the set is due.
- Homework due dates/times: Monday, 1:30pm.
- Email: padraic@math.ucsb.edu.
- Course webpage: http://math.ucsb.edu/~padraic/math108b_w2014/math108b_w2014.html.
- TA: Yihan Li.
- TA email: yhli@math.ucsb.edu
- TA office hours/location: Wednesday, 4-5pm, item TA Mathlab hours/location: Monday 3-7pm.

Course Description

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

> ***Prerequisites**: Mathematics 108A.* Diagonalization, inner product spaces, projections, least-squares approximations, invariant factors and elementary divisors, canonical forms, topics from advanced matrix theory, applied linear algebra, and group representation theory.

This is technically correct, but not very interesting. Rather, I claim the best way to think about this class is as an attempt to answer the following question:

Question 1. *Take some matrix A. What is the "simplest" possible form of A? In other words, how can we write A so that various matrix operations, like exponentiation, can be done quickly?*

There are a large number of results in this area, and an even larger set of open problems concerning how to do these things quickly, as such problems are at the heart of both practical (i.e. physics and economics) and theoretical problems that researchers study. We will examine as many of these as we can.

Course Evaluation

There are three components of your grade in Math 108B:

- **Homework** (35%.) There will be eight homework sets; they will be due on Mondays in class. Because there are more than 65 Math 108B students all being graded by the same TA, and we do not said TA to die, problem set evaluation will be done by picking a third to a half of the problems at pseudorandom and grading student performance on those 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 small quizzes throughout the course, on Wednesdays. They are meant to be a few very simple questions asking you to prove or explain some small bit of linear algebra related to what we've studied recently. 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 Friday, January 31, and a final on March 19, from 8-11am. The midterm will be worth 20% of your final grade, and the final exam 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 is the course textbook (Axler), any references posted on the course's Gauchospace, 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 one of these resources. 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.

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 108B this term. We will likely not do everything here, and we may do things not from here, depending on how the class goes and where people's interests lie.

1. Applications of eigenthings.
2. Diagonalization.
3. Change of basis matrices.
4. Inner-product spaces.
5. Orthogonality and minimization.
6. QR decompositions.
7. Singular value decompositions.
8. Jordan normal form.