Syllabus for Math 137a

Basic Course Information

- Professor: Padraic Bartlett.
- Class time/location: TTh 11-12:15, Psych 1902.
- Office hours/location: Tuesdays 1-2pm, 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.
- Email: padraic@math.ucsb.edu.
- Course webpage: http://math.ucsb.edu/~padraic/math137a_w2014/math137a_w2014.html, or Gauchospace.

Course Description

> ***Prerequisites**: Mathematics 5A or 5AI or 4B or 4BI; and Math 8 with a grade of "C" or better.* Elements of graph and network theory including paths, circuits, trees, coloring, planarity, matching theory, Hall's theorem, applications to scheduling theory, flows in networks, Menger's theorem, and other topics as time permits.

This is mostly right! For the most part, we're going to work through Diestel's Graph Theory, with occasional interludes into graph theory topics that I find interesting and do research in. As well, let me know if there are any particular topics you'd like to see — I am more than glad to adjust our planned topics to match student desires and interests.

Also, I should sound a cautionary note about the prerequisites. In a sense, these prerequisites are certainly sufficient, in that I won't be assuming much if any outside content when I teach this course. However, this class is aimed squarely at the pure mathematicians in the room — our problem sets are going to be proof-focused, our lectures are going to assume a **lot** of comfort with any and all elementary proof techniques, and we are going to move at a fairly quick clip through a lot of disparate concepts.

It's also going to be ridiculously fun.

Course Evaluation

There are two components of your grade in Math 137A:

- **Homework** (50%.) There will be four homework sets throughout the term. Because there are more than 35 of you, there is no TA, and I don't want to die, grading will work as follows:

  1. Problem sets will contain 11 questions.
  2. In each problem set, you will pick one problem to be carefully graded. This problem will be graded out of ten points, and carefully marked up.
  3. The rest of the problems will be graded on a much simpler rubric:
     - One point: you have a solution that is a complete and correct proof of the problem at hand.
     - Half a point: you have something that is mostly correct but flawed. I.e. you have a proof that's correct but you skipped a nonobvious step; you have a solution that would have worked if you hadn't messed up the arithmetic along the way; you
     - No point: your work is deeply flawed; i.e. you don't have a proof, or you're trying to prove something that is false, or your work is fundamentally flawed.

     These problems will be graded tersely (i.e. few to no comments.) That said, if you have questions on these problems, talk to me! I can explain why anything is graded the way it was in person.

  Barring a medical emergency or other similarly-drastic events, late HW will be penalized 5% per day it is late. Fun fact: this can give you negative homework scores! Please do not test this.

  When writing up your homework, make sure to clearly state the problem being solved and write down all of the steps involved in proving your answer. If you've used things like Mathematica or Wolfram Alpha, simply saying "By Mathematica, the answer is X" will result in losing most of your 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 five 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. Write proofs that you'd enjoy reading in a textbook.

  Also: if you write up your homework in LATeX, you get a free flat 5% on the problem set. If you're going to be a mathematician, you're going to need to learn LATeX eventually; you might as well start now.

- **Quizlets** (20%). There will be intermittent quizzes throughout the course. 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 quiz score will be dropped. Accordingly, no make-up quizzes will be given.

- **Exams** (30%.) There will be one test for this class; a take-home final. Details will appear closer to the relevant date.

Letter grades for this course are only determined at the end of the semester, based on the overall class performance on the 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 class textbook (Diestel,) any references posted on 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 sources. 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.

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

Course Textbook

Diestel's Graph Theory is the course text. It's well-written, covers almost everything I want to talk about, and has the advantage of being free online (you can also buy printed copies for a fairly nominal fee of like 30 dollars.

Bollobás's Modern Graph Theory is also a great book, if you want an auxiliary source to supplement your class reading. I'm also fond of the sections in Wilson and Van Lint's A Course in Combinatorics, but I think that's mostly because my advisor wrote it and it was my first introduction to a lot of concepts.

Course Timeline

The following is a rough sketch of topics that we may cover in Math 137A this term. We certainly won't cover all of these, and may cover things outside of them, but it's a sketch of some ideas to talk about. (What we don't do this term will likely happen in 137B, I believe.) Again, if you have preferences here, let me know!

1. Matching theorems and results.
2. Topological graph theory.
3. Vertex and edge-colorings of graphs.
4. Flows on graphs.
5. The art gallery theorem.
6. The unit distance graph problem.
7. Extremal graphs.
8. Perfect graphs.
9. Ramsey theory.
10. Random and quasirandom graphs.
11. Spectral graph theory.
12. Trees and the art gallery theorem.
13. Szemerédi's regularity lemma.
14. Hypergraphs.
15. The probabilistic method in graph theory.