Math 137B — Professor: Padraic Bartlett

Syllabus for Math 137B

Weeks 1-10 — *UCSB 2014*

Basic Course Information

- Professor: Padraic Bartlett.
- Class time/location: TTh 11-12:15, Girvetz 1116.
- Office hours/location: Office hours/location: MTThF, 1-2pm, South Hall 6516. These OH are shared with other classes, but there should be a lot less people in them than in the previous quarter (yay not teaching 4 classes and 140 students.)
- Email: padraic@math.ucsb.edu.
- Course webpage: http://math.ucsb.edu/~padraic/math137b_s2014/math137b_s2014.html.

Course Description

So: one frustrating thing about Math 137B's online course description is that it is **literally the same** as the 137A 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.

So! In the last quarter's run of Math 137A, we covered a ton of these topics, as well as some other fun things we visited on the way:

- Paths, circuits, and trees.
- The Art Gallery Theorem.
- Colorings of graphs.
- The (false) proof of the Four-Color Theorem.
- The Euler characteristic.
- Perfect graphs.
- Spectral graph theory.
- Strongly regular graphs.
- Ramsey theory.
- The probabilistic method in graph theory; random graphs.
- The Max-Flow Min-Cut theorem.
- Algebraic flows.

In this coming quarter, we will rarely refer to any of these past results directly: the only thing I'm assuming from you is the level of comfort that working with graphs for a quarter should give you. Instead, our focus this quarter is going to be on primarily **applications** of graph theory to other areas of mathematics, or the converse (examining where other areas of mathematics can tell us things about graphs)! In particular, I hope to cover the following five topics:

- Electrical networks, random walks, and graphs.
- Topological graph theory.
- Algebraic graph theory.
- Quasirandom graphs.
- Extremal graph theory.

It's gorgeous stuff and I'm excited.

Course Evaluation

There are three components of your grade in Math 137B:

- **Homework** (40%.) There will be weekly homework sets throughout the term. Grading works as follows:

  1. Problem sets will contain 3-6 questions.
  2. If we don't have a grader, not all problems will be graded; instead, a random selection of 2-3 problems will be picked from each set for grading.
  3. Rubrics will tend to be very simple: i.e. problems will typically be graded on a 1 (for correct), 1/2 (for incorrect but promising) or 0 (for incorrect and fundamentally flawed) scale. This may vary depending on the problem, but the spirit of "you either have created a correct solution or you have not" is what I want grading to emphasize: as mathematicians, it's not like we label things like the Poincaré conjecture with "93%, $A-$." Proofs either work or they don't, and this is what I want to emphasize in this class.

  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. HW is due at the start of class on Thursdays. Also, no more emailing of HW, because that was a nightmare for me to deal with (tons of emails, unopenable attachments, lots of printing, HW's with no name on them, etc.)

  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 are weekly quizzes. 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** (40%.) There is an in-class midterm, on Thursday, May 1st. It will cover everything covered in the first half of the class. There is also an in-class final, on Wednesday, June 11, from 12-3pm. It will cover everything discussed through the quarter. The midterm is worth 15% of your final grade, and the final is worth 25%.

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. I mean, once you understand the definitions for a question, you should certainly spend a good 30m-1h on any problem before googling around for ideas. But you are certainly not prohibited from reading outside sources to get an idea for what's going on, and indeed it may help you understand the material better!

The only things that I 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, you can directly cite and use without proof anything proven in class or in the class notes posted online. Anything else — i.e. results from textbooks, results that you find on mathexchange / Wikipedia, etc. — you need to both (1) cite in your writeup, and (2) reprove the results you're using from those sources carefully in your own words. Simply copying solutions over directly is plagiarism / cheating / otherwise poor academic form; it is passing of as your own work the ideas of others. You are certainly welcome to read and learn what other people have attempted! All I am asking you to do here is to (1) not pass it off as your own work, and (2) rephrase and present it in a new way so that it is clear that you have actually learned something.

- If you work with other students on a problem, it is considered good form to refer to them (i.e. ”I worked with Andrew Wiles on this proof of Fermat’s Last Theorem”) when writing up your solutions. I mostly ask this because crediting collaborators is something you’re going to do as mathematicians, and should get in the habit of.
- 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

Doesn’t exist. I’m writing up notes this quarter, because I wasn’t very happy with how Diestel worked out (it’s too terse for a first introduction to graph theory) and I don’t know of any other graph theory books that are any better. I may also post references / papers that are relevant to what we’re doing as secondary sources.