Math 7h | Professor: Padraic Bartlett

Syllabus for Math 7h

Weeks 1-10 | *UCSB 2013*

Basic Course Information

- Professor: Padraic Bartlett
- Class time/location: Tuesday, 5-6:15
- Office hours/location: Tuesday, 3-4pm, South Hall 6516. Additionally, I have office hours from 1-3pm TTh for my other two classes; you are welcome to attend these office hours instead if they work better for you. Finally, if none 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: Tuesdays, at the end of class.
- Homework due dates: The Tuesday after the set is handed out, at the start of class.
- 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/math7h_2013/math7h_2013.html

Course Description

Here's a fun game for you to play out in the real world: ask people what they think research mathematicians do. You'll get some pretty interesting answers, usually ranging from "count things **really** quickly" to "yell at college students about factoring polynomials."

Now, ask yourselves the same question: what do you think research mathematicians do? After all, if you're in this class you might be thinking about being a mathematician. What answers come to mind?

If you're like most first- or second-year students, you might be drawing a blank here. Thus far in your mathematical career, pretty much all of the people that you've known to be mathematicians have been teachers. Furthermore, most of the mathematics you've studied has been pretty well hammered out since the 17th century or earlier; unless you've been lucky enough to live near a math circle or spend a lot of time reading Wikipedia articles, you may have not encountered a mathematical topic that's been discovered in recent memory. So: what do research mathematicians do? What is research in mathematics like? This class is designed to answer these questions.

Over the next year, we're going to look at topics from pretty much every area of mathematical research we can get to, discuss currently open problems in mathematics, and essentially create a "preview" of what your future mathematics classes may look like. There is no required background for this course, beyond being currently enrolled in one of the university's calculus sequences; any background material that we need will be covered in lecture or homework in this class.

Also, it's going to be fun.

Course Evaluation

Math 7H is a one-unit (i.e. three-credit hour) class that meets once-weekly for a little less than 90 minutes. Accordingly, about half of your responsibilities for this course are just showing up to lecture! The rest of your grade is determined by your performance on the weekly homework sets. These sets will have a different structure than the sets you're used to:

1. The problem sets will typically contain about five multi-part problems, of a typically higher difficulty and complexity than the kinds of problems you are used to. These problems are often constructed to extend ideas from lecture, expose you to open questions in mathematics that we don't know the answer to, and illustrate what your future math classes might be like if you are a math major.

2. You will be asked to pick **one** of these problems, and work on it until either:

   (a) You solve the problem.

   (b) You have spent about 90 minutes working seriously on the problem. (Examples of nonserious work: sleeping with the problem set under your pillow, watching Sherlock with the problem set open on a second tab in your web browser, playing ultimate frisbee and looking at the problem set whenever you come off the field for water.)

   In either case, you will need to **show all of your work** in order for me to know how you derived your answer/that you've actually spent time on the problem.

3. The week after receiving the problem set, you will hand in your chosen problem along with the work you put forth on the problem. These will be graded on the following scale:

   (a) Full credit: You have demonstrated through your work that you have seriously worked on this problem for 90 minutes.

   (b) Half credit: You did a pretty poor job of actually showing your work.

   (c) No credit: A blank assignment, or just absolute nonsense.

   (d) Bonus half-credit: You actually solved the problem. (Only awarded if work is shown.)

With this in mind, this is how your grade will be determined in Math 7H:

- **Attendance** (50%.) There are 10 classes; attendance will be taken at the start of each class. Show up.
- **Homework** (50%). There will be 10 problem sets. Do them.

If you attend 8/10 classes and get 8/10 points of credit over the ten problem sets, you will get an A; other combinations that total up to 16 will also get A's. Lower performances in the class will receive proportionally lower marks, but seriously, just do the work. It'll be fun, I swear.

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 also 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, you cannot simply cite a paper: you have to write up the proofs of any results you're planning to use, and do so in your own words. The only exception to this policy is for results in the online lecture notes or from previous HW sets.
- 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. Basically, this course is covering every beautiful result I can cram into the year, so we're going to hop around topics on a weekly basis. Consequently, what I'm going to do throughout the course is type up all of my lecture notes[1] and post them on the course website. Between those and your homework sets, you should be able to do anything.

That said, whenever I'm lecturing off of a topic from a particular research paper or text, I'll make a note of it in the notes, so you have additional resources to look at.

[1] To type up my lecture notes, I use a program called LaTeX. If you're going to be a math major, you may want to consider learning how to use LaTeX yourself, as it is the tool that mathematicians use to type up pretty much anything. If you would like to learn how to use this, feel free to contact me or stop by office hours; I'd be glad to explain the basics!

Course Timeline

There isn't one. I have a large stack of lectures prepared for this course; however, I want to adjust the class as it progresses to follow what **you** are interested in! Accordingly, the topics for this sequence will shift to match the interests of the students in the course over time. This means that if there's anything you remember from a random Wikipedia article you were interested in, or from a math talk you saw once, tell me about it! There are very few limits to the mathematical concepts we can work on in this class.

That said, some topics we may discuss include:

- Cardinality: i.e. the "size" of infinity.
- The Collatz conjecture.
- Cryptography.
- The four-color theorem.
- The prisoner's dilemma.
- Combinatorial game theory.
- Electrical circuits and random walks.
- The unit distance graph problem.
- Dynamical systems and chaos theory.
- The surreal number system.
- Pen-and-paper constructions.
- The mathematics of origami.
- Stirling's approximation.
- Asymptotic series.
- Barker sequences and ECC.
- The art gallery theorem.
- The axiom of choice.
- Latin squares.
- Ramsey theory.
- Sorting algorithms.
- P versus NP.
- Generating functions.
- Graph theory (many, many subtopics.)
- Knot theory.