

## Syllabus for Math/CCS Problem-Solving Seminar II

*Weeks 1-10**UCSB 2015*

## Basic Course Information

- Professor: Padraic Bartlett.
- Class time/location: TTh 2:30-3:50, Old Little Theater 164B.
- Office hours/location: TTh 12-1:30pm at SH 6516, Su 7-8:30pm at Bldg. 494, Room 143. (The Sunday night OH will feature pancakes!)
- Email: [padraic@math.ucsb.edu](mailto:padraic@math.ucsb.edu).

## Course Description

In high school, the difficulty of most math problems you see can be measured in minutes. Exercises, typically of the form “apply method  $x$  to solve instance  $y$ ,” rarely give their students a chance to be creative or get stuck; instead, the hardest part is often just cranking through the dozens of calculations on each homework.

As you may have noticed, this is not how CCS works. Here, the scale of problems you tackle are ones you can typically measure in hours or even days! We do this because we want to make the mathematics you do at CCS more like the mathematics that we do in our own research; longer, stranger, and much more open to creative approaches.

However, research problems in mathematics are solved on the scale of **years**, not hours; questions like Fermat’s Last Theorem or the impossibility of squaring the circle took **generations** of the brightest minds to solve, and even modestly open research problems require immense effort just to fully understand their statement. In spite of this massive gulf between difficulty levels, however, most undergraduate programs in mathematics do not give their students a chance to experience problems at the size that research involves.

This seems . . . problematic. CCS, in particular, is a program designed to prepare students for future graduate-level studies. As such, we should not simply teach you the subjects you will need for graduate-level work; we should also expose you to the **scale** of problems you will see there!

This is the point of this class. In this run of Problem-Solving, you will be working on a single problem or family of problems for an entire quarter. Many of you will tackle open problems, some of you may even discover new results in mathematics, and at various points in times **all** of you will get stuck. It’s going to be fun!

## Course Structure

To make this course work, we need to have a class structure that emulates how research is done in the real world. Accordingly, we will have the following:

- **Quarter-long projects.** Before the quarter started, in the same email that contained this email, I sent out descriptions of several different sorts of research problems.
- **Groups.** From there, I will use your preferences to divide the class into **four** distinct research groups of students. Throughout the quarter, you will work with your group on this project.
- **Weekly meetings.** Each week, each group will have a 45-minute slot in which to meet with me outside of class. Meetings do not need to take the entire 45 minutes; they exist to give you a place to ask questions and talk informally about research directions.
- **Weekly writeups.** Each week, each group will prepare a writeup of their results thus far. Writeups should be at least 3-5 pages long, and contain all of the definitions, examples, theorems, proofs, and sources that your group studied over the past week. Writeups need to be submitted by paper and by email by the start of the class in which these results are presented.
- **Weekly presentations.** In class each week, each group will prepare and deliver a 25-minute long presentation that describes their current research progress. Two talks will be delivered in each class.
- **Quizzes.** At the start of each class, we will have a brief (10m) quiz with two problems, one for each of the two presentations in the previous class. The quiz problems will be created by the groups who presented on that previous class. Quiz problems and their solutions need to be submitted by their associated groups before the start of said previous class.

## Course Evaluation

There are three components of your grade in this class::

- **Presentations (30%).** Presentations are graded and awarded on a group-by-group basis, with a fairly coarse grading scheme:
  - 0-3 points: The content of your presentation. Presentations either are (factually speaking) perfect, have minor flaws, or have major flaws, which corresponds to 3/2/1 points respectively.
  - 0-2 points: The style of your presentation. Presentations in which students have clear board-work, communicate well with the class, and otherwise present clearly will receive a point here; those that do not will not. No partial credit.
  - 3 points: Failing to present at all will give you and your group -3 points. (Why yes, that **is** a negative number.)

Additionally, for any individual to receive credit for their presentation score, they must lead at least one full presentation over the quarter (or if your group splits presentations amongst multiple people, enough partial presentations to add up to at least one presentation.) Failing to do this will scale your score here to the total number of partial presentations you do run, all the way down to 0%.

- **Writeups (30%).** Writeups are also graded and awarded on a group-by-group basis, with a fairly coarse grading scheme:

0-3 points: The content of your writeups. Writeups either are (factually speaking) perfect, have minor flaws, or have major flaws, which corresponds to 3/2/1 points respectively.

0-2 points: The style of your writeup. Writeups in which students have clear proofs and reasoning will receive 2 points; writeups with some good proofs and some bad proofs receive one point; those that are poor in quality will receive no points.

Sourcing, in particular, is an area where you will lose points if you do not include in each writeup. Every writeup should have an accreditation/sourcing section, in which the following happens:

- \* The individual people who physically wrote up this week's writeup are credited, with specific sections labeled where appropriate.
- \* All of the webpages, books, articles, and other sources you have referred to are listed. You may likely want to look into using LaTeX's **bibliography management tools** for a nice way to do this, though this is not necessary.

-1 point: For each day your writeup is late, a point is deducted. Anything later than the start of class counts as late for that day. If an assignment is never turned in, the entire writeup will receive a -3, which is similar to what happens with presentations.

Additionally, for any individual to receive credit for their writeup score, they must author at least one full writeup over the quarter (or if your group splits writeups amongst multiple people, enough partial writeups to add up to at least one presentation.) Failing to do this will scale your score here to the total number of partial writeups you do, all the way down to 0%.

- **Administrative things. (10%).** As you noticed above, your groups are responsible for writing the quiz problems! Here's how points work for this.

1 point: Your group needs to submit a quiz problem and solution before the start of the class in which they present their results. I will accept almost all proposed quiz problems, but retain the right to reject overly easy (i.e. "2+2") or difficult (i.e. "Is  $P = NP$ ?") exercises.

0 points: Your quiz problem/solution is late, but still arrives in time to be printed on the quizzes for the appropriate class.

-1 point: You do not turn in a quiz problem and solution.

- **Quizzes (30%).** There will be quizzes at the start of each class. Each quiz will have two problems; each problem will be graded with a correct/incorrect metric, with no partial credit.

If a group does not submit a problem in time, then the associated quiz will simply have one less question than normal, and count for one less point.

This course is pass-fail and for four units. As defined by the CCS Mathematics department, your percentage score in this class is transformed into units as follows:

- Students receive five units (i.e. the full four units, plus a bonus unit to recognize strong work) for work at or above the A- level.
- Students receive the full four units for work at or above the B level.
- Students receive three units for work at or above the C level.
- Students receive no units for work below the C- level.

The correspondence between percentage marks and letter grades depends heavily on class performance. Talk to me during the course for more information!

## Collaboration/resources policy

All resources are legitimate, but everything must be written up in your own words. All outside resources you read, consult, or refer to must be listed in your bibliographies.

## Potential Challenges

This will be a challenging course for many reasons. One of the more obvious points of difficulty is that many of you will be working on open problems, and all of you will be working independently on mathematics that is new to you! In doing this, some level of confusion / “getting stuck” / challenge should be expected. However, you may find your entire group getting more frustrated than seems useful.

If this happens, and group meetings don’t help you get unstuck, remember the following: your projects throughout this class are more suggestions than assignments! If you come to a point where your group is frustrated with your current question, but find yourself interested in side projects, feel free to explore those directions.

That said, a second challenge here for many of you may be **learning to work in groups**. Collaboration with other researchers is how almost all work is done in modern scientific endeavors, which is why I’m pushing it; however, it is very much a **learned** skill. You will need to figure out, on your own, how to divide up tasks like the presentations and writeups, how to tackle problems as a collective, how to help group members that fall behind, and how to make sure everyone is working to their fullest potential.

This is very hard! In doing this, you may find yourself running into problems; if this happens, do not hesitate to talk to either me or (perhaps more usefully) your group. In either case, we can work together to make this class a productive yet challenging environment for all of you.