Math 2110: Introduction to Proof & Logic: Final Projects

Your last task this semester is a small project. You will pick a topic related to, but yet, a little beyond what was covered in class. Then you will write up your findings and record a short presentation.

Due Date: The paper and recorded presentation are due by **Monday, May 4th at noon**.

Here is what I expect from you (and what you will be graded on):

Project Proposal Pick out a topic and outline what you plan to study. Then talk to me about it. I will give you some suggestions (possible examples, problems, theorems to consider).

Due: No later than **Friday, April 24th**.

The Paper Your paper should be similar in structure to the one you did for your midterm mini-project.

- The paper should be *at least* 5 pages long. As you try to fit in the other requirements, you may find that it grows to be a bit longer. The average paper length from previous classes was about 7-8 pages.
- This should be typed up nicely in LaTeX.
- Your classmates are your audience. Make sure your paper is understandable from their current level of mathematical education [build on what we covered in class].
- The first page should include title, author, and abstract.
- You should have a list of references at the end of your paper. You should have *at a minimum* 3 references. Make sure *at least* 1 reference is a SOLID reference (i.e., something published and peer reviewed like a research article or textbook).
- Begin your paper with some background about your topic. Include some history. If you were studying Hilbert spaces, you should indicate who first defined such a space and maybe give a brief biography of that mathematician. If your topic doesn't lend itself to such a discussion, pick a prominent mathematician who made a big impact on your topic and give a brief biography.
- Your paper should include at least 1 "big theorem" and its proof.
- You should give at least 3 "concrete" examples illustrating your topic.
- You should do at least 3 "homework problems" related to your topic. (These could be calculations or some easy-to-prove theorems – just think of something I might assign if we covered this in class.)
- Your paper should include a discussion of some application of your topic. This can be a scientific, "real-world", or mathematical application.
- Ideally, you should do a inductive proof and proof by contradiction somewhere in the paper — if you can't come up with a reason to use these techniques, come talk to me. I'll try to help you find a way to fit these things in somewhere. (Some topics just don't lend themselves to inductive proofs.)

The Presentation Everyone should record a 10 minute (*approximately*) presentation about their topic. Sum up what you learned. Give some examples. Describe your big theorem and at least "sketch" its proof. Create slides. You can either use LaTeXor Powerpoint or whatever looks good.

Point breakdown: Paper 75%, Presentation 25%.

Random Topic Suggestions!!!

Here are some suggested topics. Your don't have to pick from this list, these are just random suggestions. By the way, if you pick a topic closely related to someone else's topic, please feel free to coordinate your papers and presentations — you still have to write up your own stuff, but you can build off each other's background.

- Mersenne primes and perfect numbers.
- Error correcting codes, cryptography, and modular arithmetic.
- What is a Lie algebra?
- Difference equations.
- Cauchy Sequences. A metric space is called "complete" if every Cauchy sequence converges. It can be proved that every metric space can be embedded in a complete metric space. The real numbers are complete in this sense.
- Uniform continuity — a powerful assumption.
- Normed spaces and inner-product spaces.
- Path connected. Every path connected space is connected. But the converse does not hold. Path connectedness is more commonly used than regular connectedness.
- Product and Box topologies. Given topologies defined on spaces X and Y one can define a topology on $X \times Y$. This can be done for infinite cartesian products as well. The product of compact spaces is still compact.
- Symmetric groups and group actions. One can easily classify the platonic solids. Each of these has a group of symmetries. The rotational symmetries of the icosahedron form the smallest non-abelian simple group.
- Quotients of groups, vector spaces, topological spaces. Gluing topological spaces together.
- De Rham cohomology and the generalized Stoke's theorem.
- Dual spaces and bounded linear operators. What does bounding an operator's norm have to do with continuity?
- Sizes of infinity and transfinite induction.
- Permutations and determinants
- Change of basis in linear algebra and Jordan form. Matrix exponential.
- Complex variables. Better than Taylor series it's....Laurent series! How the coefficient of x^{-1} computes integrals.

. . . Don't see anything that strikes your fancy? Come talk to me, maybe I help find a topic for you.