

Math 4981 Paper Rubric

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The paper is worth 20% of your final grade in the course. Of this, 10% is for turning in a complete draft by Monday, April 12. If I do *not* have a draft by noon on Monday, or if the draft is substantially incomplete, I will penalize your score. I strongly recommend that you discuss your topic with me by Friday, March 26. (I also strongly recommend you start writing your paper before April 11).

I will give the first draft detailed comments and a “shadow grade ” which does not affect your course grade in any way; you will get 100% of the possible credit for the rough draft simply by turning in a draft paper (not an outline!) of acceptable length on an acceptable topic. The shadow grade is to guide you as you do revisions, and corresponds to the grade I would give the rough draft if it were submitted as a final draft.

The final draft will be due on April 30. It will be graded according to the attached rubric.

Some Topic Ideas

You can read up on most of these topics in the course textbook. I also encourage you to check Wikipedia for a quick overview of any that look interesting.

For all of these topics, remember it’s important to discuss mathematics. A paper on the social role of cryptocurrency might be interesting, for instance, but for this assignment you should focus on the mathematics that underpin it and not the social consequences.

- Pseudorandom number generators
- Hashing functions and collision attacks
- More on elliptic curves
- More on lattice-based cryptography
- Digital signatures
- Zero-knowledge proofs
- Cryptocurrency
- Coding theory: Compressing codes and Error-Correcting Codes
- Vulnerabilities in RSA (e.g. Coppersmith)
- Primality testing
- Factoring Algorithms such as the Quadratic Number Field Sieve

What your Paper Should Look Like

I expect a paper in the 4-5 page range. Any shorter than that and you'll probably have trouble developing a full argument; much longer and you're probably either giving too many details, or doing too much work. (Don't stress about actually hitting the four-page mark; in my experience, once you start including mathematics you'll reach four pages much more quickly than you expect. This is especially true since many equations should be set off on their own line. A four-page math paper has many fewer *words* than a four-page paper in a typical humanities course.)

The easiest way to get good, professional-looking math formatting is to use L^AT_EX (which is what I used to make this document, and all my other course materials). If you are starting with LaTeX, I recommend using Overleaf, although there are many good options. I have a list of LaTeX resources at <https://jaydaigle.net/latex/>, including a template paper document, if you want to learn more, and would be happy to help you set it up. However, LaTeX isn't mandatory, and I will happily accept papers written in Word or anything else; just make sure your mathematics is formatted cleanly.

Rubric

35 points **Mathematical Content**

I will evaluate the mathematical content of your paper. I won't break this down into sub-topics with fixed numbers of points because different papers will have different types of content in different ratios—for instance, some topics will require many definitions and some will require only one or two. I will be looking for a few things:

- The centerpiece of your paper should be at least one substantial mathematical idea or result. This can be a theorem or a computation, but should involve doing some mathematical work.
Every claim should be stated clearly, precisely, and correctly, in formal mathematical language. When possible, claims should also be explained informally, to help readers figure out how to think about them.
- Your paper should clearly define any terms you expect your fellow math majors, and any terms that are central to your paper. Definitions should be clearly and precisely stated, and ideally come with a sentence or two explaining how your readers should think about the concept being defined.
- The bulk of your paper should be the computations and proofs that justify your main results. The proofs should be correct, clearly written, and display understanding of the details of the argument and the topic. Again, try to give a technical argument and also an explanation of how to think about it—an intuition or motivation.
- It is permissible—and often more-or-less necessary—to use some results which you do *not* prove. Any such results should be clearly stated, and you should give a citation for where the reader can look up details of the result.

35 points **Style and Framing**

4 points: Title

The paper should have a clear title, and below the title should give the name of the author and the author's college affiliation, with nothing else before the abstract.

6 points: Abstract

A good paper should begin with an *abstract*, a 3-4 sentence sales pitch explaining what your paper covers and why one might be interested in it. A good abstract tells the reader what the main result or conclusion of your paper is; identifies the main tool or tools used to reach that conclusion; and gives some perspective on how this conclusion relates to other topics your reader may be interested in.

Crucially, the abstract is not actually part of your paper; it is how your reader decides whether to look at your paper in the first place. The abstract does not replace the introductory paragraph, although your first paragraph may contain some of the same information as your abstract. The abstract should stand alone as a summary of the paper, and the paper should also stand alone if the abstract is omitted.

10 points: Framing material

Your paper should feature an introduction (and possibly conclusion), which put your result or problem in context and explain why people were interested in it. The introduction should provide some historical topic on your problem (when was it first studied? When was the core problem solved?), as well as a discussion on how your topic relates to other topics in mathematics. If your paper has more than one main result, you should explain how these results relate and form one cohesive paper.

When possible, your results should be related to topics which are at least one of

- Practically applicable
- Interesting to a great many people
- Something we have studied in this course.

10 points: Writing style

Your paper should be well-organized, with transitions that flow from one section to the next. It should be free of obvious grammatical and spelling errors, and formatted legibly. (If the act of reading your paper is painful or unpleasant, this is where I can take points off).

5 points: Appropriate use of references

Your paper should cite at least two references. They should be cited appropriately when used in the body, and also listed in a "References" section at the end of the paper. (If you use \LaTeX , the BibTeX package should make this nearly automatic. In any case you can usually find properly-formatted references by looking your source up in Google Scholar and clicking the quotation-marks icon.) I encourage you to use the course textbook as one of your sources.