18.704: SEMINAR IN ALGEBRA

SPRING 2022 SYLLABUS

18.704 is run in the style of a seminar: The students (*i.e.*, YOU) take turns presenting the subject matter week by week. I will help each speaker practice their talk beforehand. Students will also write expository papers about their final topics, to be posted on the course webpage:

https://math.mit.edu/~mqt/math/teaching/mit/18-704/

The Spring '22 topic is *harmonic analysis on finite groups and its applications*. In the first half of the course, we introduce the discrete Fourier transform and apply it to graph theory, probability, coding theory, and physics. In the second half, we discuss its nonabelian generalization, focusing on matrix groups over finite fields.

Instructor	Minh-Tâm Trinh (mqt@mit.edu)
WRAP Lecturer	Susan Ruff (ruff@mit.edu)
Time & Place	MWF 1–2 PM, Room 2-151
Textbook	Terras, *Fourier Analysis on Finite Groups and Applications*
Supplements	Etingof *et al.*, *Introduction to Representation Theory* Mackey, "Harmonic Analysis as the Exploitation of Symmetry" Piatetski-Shapiro, *Complex Representations of* $\mathrm{GL}(2, K)$ *for Finite Fields* K Sloane, "An Introduction to Association Schemes and Coding Theory"
Grading	60% Talks 1-4 (*weakest talk dropped*) 25% Talk 4 paper 15% Participation

Grading will be lenient. But to earn a "pure" A, you will need to put in effort beyond the bare requirements. There will be no problem sets and no exams.

Logistics

Blocks & Talks. The semester will be divided into four *blocks*. Each consists of nine days of class. Within a block, students will take turns giving presentations until everybody has given one. So on average, two students will present per day. Each block will also include a *buffer day* when people can do make-up talks and we can review the math we've recently covered in more detail.

Altogether, you will give four talks during the semester. I will send you feedback after each talk, highlighting both the things you did well and the things that could use improvement. It's ok if you bungle a talk: I will drop the weakest one from that component of your course grade.

As you gain more and more practice, the expectations will ramp up accordingly. In particular, for talk 4, you will write and submit a short paper about your topic in LaTeX (*see below*).

(1) In block 1, you must meet with me in the week preceding your talk to do a practice run. It's best if you can practice jointly with the other person who will present that day. By the end of the block (**Feb 25**), you must choose your topic for talk 4, so that you can begin working on the outline of the paper. (Topic choice will be first-come-first-served.)
(2) By the end of block 2 (**March 18**), you must send me an outline of the sections in your paper. Ideally, it will specify which sections will cover which definitions, examples, and/or theorems. Since preparing the outline will require you to jump ahead in the textbook, you are encouraged to run your ideas by me over email before you submit the outline.
(3) During block 3, I will randomly match you with a classmate who will proofread the rough draft of your paper. By the end of the block (**April 15**), you must email the rough draft to your classmate and ~~to me~~ cc Susan Ruff and me.
(4) By the end of the second week of block 4 (**April 29**), you must email the classmate whose paper you proofread with your feedback. If you prefer, you may send your comments in a file attachment. Please cc me on the email. The final draft of the paper will be due on the final day of class (**May 9**). It will be posted online.

While practice talks are not required in blocks 2-4, they may be very helpful. You are always welcome to contact me or Susan Ruff (*see below*) to schedule one.

The Final Paper. I will provide a LaTeX template for the talk 4 paper, to keep things standardized. The paper should include strictly more material than the talk itself. In particular, **it must include some explicit calculation or example not already present in the textbook**. It should be:

- ~~**5-10 pages long**~~ **At least four pages long**, including references
- targeted toward an audience of your classmates
- written in a formal register
- as free of grammatical or mathematical typos as possible

It will be graded on clarity of content and professionalism of writing. I will send more information about the paper, and the template, as the semester progresses.

Communication Training. Giving a formal talk, and writing a formal exposition, are almost always harder to do than students believe. We are lucky to have Susan Ruff, a lecturer in the Office of Writing, Rhetoric, and Professional Communication, available to provide guidance about how to do these well. In particular:

- In the first week of the course, we will reserve (part of) a day to talk about the components of a good talk (*e.g.*, emphasis, time management, boardwork, audience engagement).
- In the first week of block 3, we will reserve part of the buffer day to talk about the components of good expository writing (*e.g.*, organization, use of subdivisions, use of centered displays, putting math inside prose).

As far as expository writing, here are some choice starting resources:

J. S. Milne: "Tips for Authors" and "Mathlish"

J.-P. Serre: "How to Write Mathematics Badly"

Susan Ruff has asked me to emphasize that "Tips for Authors" is a *humorous* collection of *bad* writing tips.

Failsafes

If you get sick, **please don't come to class!** (Regardless of whether it's COVID or something else.) Stay at home, take care of yourself, and notify me as soon as possible. Talks can be postponed to buffer days, or even to the last day of the semester if necessary.

If you want to follow along from home, please get in touch with me or with a classmate. We will use Zoom to allow people to watch talks online and/or record them for later.

Similarly, if I get sick, I may need one of you (*e.g.*, the speaker) to help me watch or record the talk via Zoom on your computer. For this reason, please bring the relevant tech devices on the day you present.