SEMINAR IN NUMBER THEORY

Course 18.784,   TR 1:00pm – 2:30pm,   Room 2-151

Instructor: Robin Zhang
Email: robinz@mit.edu
Office Hours: TBA, Room 2-238.

Communication instructor: Emily Robinson (Comparative Media Studies/Writing)
Email: erobin73@mit.edu

Course Website: https://math.mit.edu/∼rzhang/teaching/useminar_s25.html
Course Slack: https://mit-18-784-2025sp.slack.com/

1. COURSE DESCRIPTION

Welcome to the Seminar in Number Theory course! This semester, we will explore arithmetic dynamics – an area of mathematics that studies how numbers move. The subject lies at the intersection of dynamical systems and number theory, involving a breadth of mathematical disciplines including:

- Algebraic geometry
- Algebraic number theory
- Algorithmic number theory
- Analytic number theory
- Combinatorics
- Complex analysis
- p-adic analysis
- Representation theory

In a seminar, mathematicians help each other learn a body of material. The main objectives of this undergraduate seminar are for you to:

(1) help each other learn various topics in arithmetic dynamics, and
(2) help each other improve skills related to presenting, discussing, writing, and reading mathematics research.

This course is a Communication Intensive in Mathematics (CI-M) for undergraduates at MIT. You will give short presentations on specific topics in arithmetic dynamics, give constructive feedback on other students' presentations, and prepare a short paper on a topic in arithmetic dynamics.

2. PREREQUISITES

Students taking the course are required to already have fulfilled one of the two following bullet points:

- Algebra 1 (18.701); or
- Modern Algebra (18.703) and Linear Algebra (18.06 or 18.700).

Students who have learned similar material elsewhere may contact the instructor for prior permission to take the course. Additional mathematical background, such as elementary number theory (18.781) and Galois theory (18.702), will be helpful but not required.

Any questions about course registration and waitlists can be directed towards Charlotte Rubel (crubel@mit.edu).

3. Course Outline

3.1. **Grading Policy.** Your final grade will be according to the following formula:
- **Presentations**: 55%
  - 20%: two pair presentations
  - 10%: short solo presentation
  - 25%: long solo presentation
- **Final paper**: 35%
- **Peer critique**: 10%
  - 5%: constructive feedback of other students' presentations
  - 5%: written feedback for other students' paper second drafts

There will be *no extra credit*. Late submissions of drafts and feedback will be penalized by 1/4 of the available grade per 24 hours. Class absences will also negatively affect the final grade.

3.2. **Presentations.** You will present to your classmates multiple times during the course of the semester:
- A 3-minute presentation on a favorite definition/example/theorem, to help your classmates get to know you.
- Two 35-minute (30-minute talk + 5-minute Q&A) paired presentations on an introductory topic in arithmetic dynamics.
- A 20-minute (15-minute talk + 5-minute Q&A) solo presentation on a topic in arithmetic dynamics.
- A 35-minute (30-minute talk + 5-minute Q&A) solo presentation on the topic of your paper.

The presentations (excluding the 3-minute presentation) will be graded on:
- mathematical correctness (e.g. consistent notation, mathematical motivation, rigor);
- clarity (e.g. appropriate level of detail, examples, pacing, handwriting, board use); and
- audience engagement (e.g. questions to the audience, enthusiasm).

Presentation dates and rubrics will be provided on the course website.

Comparative Media Studies/Writing lecturer Emily Robinson will lead two in-class workshops on effective mathematical presentation.

There will be no late or make-up presentations. Missing a presentation due to medical emergencies or other urgent matters must be referred through Student Support Services (S3).

3.3. **Final paper.** You will write a paper on a topic in arithmetic dynamics. The paper does not need to contain original results, but the writing must be your own and all sources must be properly cited (ask if you have questions). The paper must be written in the style of a research or expository journal article and must be 8 to

12 pages long in LaTeX with the amsart class on default settings (10 point font, standard margins, standard spacing).

The paper will be completed in stages:

- Topic proposal
- First draft for instructor feedback
- Second draft for feedback from peers
- Final draft of the paper

The paper will be graded based on:

- mathematical correctness (e.g. synthesis of sources, rigor);
- exposition (e.g. cohesion, concisiveness, motivation, appropriate citations, examples); and
- writing process (e.g. successful revisions, incorporation of feedback).

Due dates and rubrics will be provided on the course website.

Comparative Media Studies/Writing lecturer Emily Robinson will lead an in-class workshop on reading research papers and an in-class workshop on writing research papers.

3.4. **Peer critique.** After each class, you will fill out a form to give helpful comments on each day's presentations. Think about what went well during the presentation. Think about what the speakers could have done to help the audience understand certain points better.

You will also provide written feedback for the second drafts of two other students' papers. After carefully reading the drafts, you will prepare a list of suggestions typed in LaTeX of at least one full page in length.

The peer critique grade will be based on the timely return of your feedback.

3.5. **Attendance.** In-person attendance of the course is mandatory. Reasonable excuses, which should be referred through Student Support Services (S3) and then emailed to me as far in advance as possible, may be accommodated. Unexcused absences will negatively affect your final grade.

3.6. **Collaborative work and academic integrity.** Collaboration in this course is encouraged; please feel free to use the course Slack channel: http://mit-18-784-2025sp.slack.com/. You may brainstorm ideas and discuss preparation for the talks and paper with other students. You may also ask other students for help with LaTeX formatting, commands, templates, etc. However, all drafts of the paper must be written by yourself.

Large language models (LLMs) and other artificial intelligence (AI) tools may *only* be used to help generate ideas during the topic proposal phase or to find LaTeX commands – but be warned that even the best AI tools currently have a very poor (but misleadingly confident) grasp on research mathematics. The Institute's Communication Requirement was created (in part) in response to alumni reporting that writing and speaking skills were essential for their professional success. Since this is a college writing and communication course designed to improve core rhetorical skills, the unauthorized use of text generated by LLMs and AI tools is prohibited in this course. Any such use by a student will be treated analogously to plagiarism.

MIT's policies on academic integrity, explained at https://integrity.mit.edu/, will be enforced. Consequences may include automatic failure in the course and formal filings with the MIT Committee on Discipline (COD).

4. Resources

4.1. Communication resources. In addition to the assistance you will receive from your peers and me, help with presenting and writing is available from the course communication instructor, Emily Robinson (erobin73@mit.edu).

General help with writing and presenting (not specific to mathematics) is available from MIT's Writing Center: https://cmsw.mit.edu/writing-and-communication-center.

4.2. Student Support Services (S3). Personal and medical issues can make it hard to focus on academics. If you find that something is getting in the way of your ability to attend class, complete work, or take an exam, you should contact a dean in Student Support Services (S3). The deans will provide you with support and help you work with us to determine next steps. We ask that you go to S3 so we know you have had a chance to talk through your situation with someone and to connect with any resources you might need. You can reach out to a dean you have worked with in the past, join their virtual help queue (https://sicp-s3.mit.edu/queue), or e-mail s3- support@mit.edu.

4.3. Disability and Access Services (DAS). MIT is committed to the principle of equal access and we want all of our students to feel welcome here. Students who need disability accommodations are encouraged to speak with Kathleen Monagle, Associate Dean, prior to or early in the semester so that accommodation requests can be evaluated and addressed in a timely fashion. Even if you are not planning to use accommodations, it is recommended that you meet with DAS staff to familiarize yourself with the services and resources of the office. You may also consult with Disability and Access Services in 5-104 or at 617-253-1674. If you have already been approved for accommodations, please contact me early in the semester so that we can work together to get your accommodation logistics in place.