Instructor:	Stephen McKean	**Time:**	Tuesdays and Thursdays, 9:00am - 10:15am
Email:	smckean@math.harvard.edu	**Place:**	Science Center 507

Website: The course website will be on Canvas.

Office hours: See this announcement for a comprehensive list of office hours.

Class Notes: See this link for a running overleaf document of the class notes, taken live during lectures. See this link for an overleaf document of in-progress supplemental lecture notes (on group theory).

Description: This course provides an introduction to conceptual and axiomatic mathematics, the writing of proofs, and mathematical culture, with sets, groups, and real analysis as the main topics. Beyond the mathematical content of the course, you will learn how to present mathematics in written form (using LaTeX) and oral form (through presentations).

Suggested Prerequisites: There are no hard prerequisites for this course beyond an interest in mathematical reasoning. Comfort with high school algebra and some familiarity with calculus would be helpful but are not necessary.

Topics: Here is a short list of some topics that I hope to cover in the course.

- Proofs and set theory: induction, contradiction, sets, maps, functions and relations, cardinality, different sizes of infinity, the axiom of choice.
- Group theory: groups, subgroups and quotient groups, symmetries of Platonic solids, symmetric groups, group actions, counting orbits, free groups, the Cayley graph, group presentations.
- Real analysis: constructing the real numbers, Cantor sets, convergence of sequences and series, the Euclidean topology, metric spaces, continuity, differentiation.

Textbooks: There are three official course textbooks, as well as some optional supplemental material. All of these are freely available to Harvard students (or the general public) at the provided links.

- *Book of Proof* (third edition), by Richard Hammack
- *A Book of Abstract Algebra*, by Charles Pinter
- *Understanding Analysis*, by Stephen Abbot

Supplemental materials:

- *Naive set theory*, by Paul R. Halmos
- *Algebra*, by Thomas Hungerford
- *Principles of mathematical analysis*, by Walter Rudin

Course Structure: The course will consist of interactive in-person lectures, weekly assignments, monthly exams, and a final presentation. The best way to learn proof-based mathematics is by doing. The assignments and evaluations in this course are intended to give you plenty of practice understanding, constructing, and explaining proofs.

- **Lectures (10%):** Students are expected to attend and actively participate in lectures. Every lecture will consist of many breaks for exercises, questions, and discussions. Participation credit will be recorded during each lecture. Every student is allowed 2 unexcused absences. Any other absences should be discussed with the instructor as soon as possible.
- **Weekly homework (30%):** Each week, there will be a short homework assignment to be completed and typed up using LaTeX. Templates will be provided to help students learn how to use LaTeX. Students are encouraged to collaborate on these assignments. Assignments will be graded based on the correctness of solutions, the clarity of explanations, and the neatness of typesetting. Late work will not be accepted. The lowest homework grade will be dropped.
- **Monthly exams (45%):** There will be three monthly in-class exams (February 20th, March 26th , April 23rd), each worth 15% of the final grade. Each exam will focus primarily on recent material, but topics from earlier in the course will also appear. Exams will be graded based on the correctness of solutions and the clarity of explanations.
- **Final presentation (15%):** Students will prepare and give a 10 minute chalkboard presentation on a mathematical proof. The possible topics for these presentations will be announced at the beginning of April. Presentations will be individually scheduled outside of class time. Presentations must be completed by April 24th. Presentations will be graded based on the correctness of the proof and the clarity of the presentation.

Grading Policy: Letter grades will be assigned as follows.

		A:	[93%, 100%]	**A-:**	[90%, 93%)
B+:	[87%, 90%)	**B:**	[83%, 87%)	**B-:**	[80%, 83%)
C+:	[77%, 80%)	**C:**	[73%, 77%)	**C-:**	[70%, 73%)
D+:	[67%, 70%)	**D:**	[63%, 67%)	**D-:**	[60%, 63%)

Classroom Climate: Proof-based math feels very different from the sort of math you might be accustomed to, so this class may be a bit of a shock to your system. It is my goal as the instructor to give you all the support you need to succeed, and to make this course welcoming and rewarding for all. I will actively work to create an environment in which students feel excited to ask questions, offer suggestions, and make mistakes. I ask that all students also commit to making this course a supportive and kind community.

Academic Integrity: All students are expected to be honest with themselves, their peers, and the instructor. Students are encouraged to talk with each other about the homework problems. When submitting your assignments, you should clearly acknowledge any people or resources that you consulted while preparing your work. Collaboration is not allowed on any exams.

Internet Resources: Students should also refrain from consulting online resources such as stackexchange and ChatGPT. While these are useful tools, being stuck is an essential part of learning math. It is very easy to develop the reflex to search for hints or answers as soon as you are stuck on something, and this will greatly hinder your learning process. If you are stuck on a problem, feel free to ask the instructor for help. (This also means that you should start working on assignments well before the deadlines.)

Accommodations and Questions: Please reach out to me in person or via email if you have any questions, need any additional support, or if you would like to discuss expectations, accommodations, or concerns.

Anticipated Schedule: This is a tentative schedule of what I hope to cover in the course. Exam dates are highlighted.

	Tu	**Th**	**Topic**	**Reading**	**Homework**
Week 1	1/23	1/25	Sets and logic	*Book of Proof*, Sections 1.1-1.2 and 2.1-2.12	HW 1 (due 1/31 at noon)
Week 2	1/30	2/1	Subsets, power sets, and proof techniques	*Book of Proof*, Sections 1.3-1.4 and 4.1-6.4	HW 2 (due 2/7 at noon)
Week 3	2/6	2/8	Functions, relations, and induction	*Book of Proof*, Sections 10.1-10.5 and 11.1-12.6	HW 3 (due 2/14 at noon)
Week 4	2/13	2/15	Cardinality and infinity	*Book of Proof*, Sections 14.1-14.4	HW 4 (due 2/21 at noon)
Week 5	**2/20**	2/22	Definition and basic properties of groups	*A Book of Abstract Algebra*, Chapters 2, 3, 4, and 11	HW 5 (due 3/1 at noon)
Week 6	2/27	2/29	Homomorphisms, subgroups, and quotient groups	*A Book of Abstract Algebra*, Chapters 5, 6, 9, 14, and 15	HW 6 (due 3/8 at noon)
Week 7	3/5	3/7	Symmetric groups and actions	*A Book of Abstract Algebra*, Chapters 7, 8, 10, 12, and 13	HW 7 (due 3/22 at noon)
Week 8	3/12	3/14	Spring break	Maybe some poetry or fiction?	Catch up with a friend
Week 9	3/19	3/21	The isomorphism theorems and classifying finite abelian groups	*A Book of Abstract Algebra*, Chapter 16	HW 8 (due 3/29 at noon)
Week 10	**3/26**	3/28	Sequences and the real numbers	*Understanding Analysis*, Chapters 1 and 2.1-2.3	HW 9 (due 4/5 at noon)
Week 11	4/2	4/4	Series and topology	*Understanding Analysis*, Chapters 2.4-2.9 and 3	HW 10 (due 4/12 at noon)
Week 12	4/9	4/11	Continuity	*Understanding Analysis*, Chapter 4	HW 11 (due 4/19 at noon)
Week 13	4/16	4/18	Differentiation	*Understanding Analysis*, Chapter 5	
Week	**4/23**				