
Math 74: Transition to Upper Division Syllabus

Course Goals: Stepping into your first upper division math course can be a scary thing. Unlike other subjects, the difference between lower and upper division courses in math can be quite overwhelming, the two main culprits being writing proofs and abstract concepts. In this course we will address these issues head-on. In particular, we will learn how to write proofs and develop good mathematical style and we will give students more familiarity with the mathematical objects appearing in Math 104 and Math 113.

Course Description: Here's an overview on how the class will be run. There will be two lectures each week. The lectures will go over a strict subset of the material in Math 104 and Math 113. However the topics will just be a medium for learning how to write proofs. The essential parts of the lectures will consist of guided discussions through proofs of various theorems and exercises. Here we will unravel what makes a proof hard, as well as pick up proof techniques along the way.

Each lecture 2-3 students in the class will be in charge of taking notes and to collaboratively write them up on sharelatex. This will serve a dual purpose. (1) Many people just furiously copy the chalkboard and don't actually follow what the lecturer is saying in class. This might have worked in high school but things are different in college. Now, because the notes will be online, stop worrying about copying the chalkboard and instead focus on actively learning. (2) Writing up what you learned in your own words helps a lot with achieving deeper understanding. Frequently you only have a fuzzy idea of what is going on until you are forced to explain it and it is only then that you can find out exactly what you do and don't understand.

Course Content:

- *Algebra:* Groups, homomorphisms, generators, cosets, normal subgroups, quotient groups, Lagrange's Theorem.
- *Analysis:* Metric Spaces, open and closed sets, compact sets, Heine-Borel, convergence of sequences, cauchy sequences, $(\epsilon-\delta)$ continuity, topological continuity, connectedness.

Near the end of the semester, we will give a lecture or two on topological groups, which combines what we learned above giving a beautiful interaction between two big pillars of mathematics. Time permitting, other topics by popular request may be included as well.

Textbooks: The following is a list of books I will draw material from.

- J. Fraleigh, *A First Course in Abstract Algebra*

- D. Dummit and R. Foote, *Abstract Algebra*
- W. Rudin, *Principles of Mathematical Analysis*

Prerequisites: If you intend on taking either Math 104 or Math 113 this spring and are uncomfortable with proofs, intimidated by abstraction, or just want some additional support, I *strongly* recommend you take this course. If you have taken already taken Math 104 or Math 113 but are a bit shaky on the material, I also encourage you to come. The formal prerequisite will be Math 55, all other material will be self-contained. If you are interested in the course and will be taking Math 55 this spring, please email math74.berkeley@gmail.com and we will proceed by a case by case basis.

Grading: Pending approval, this will be a 2 unit P/NP course. Your grade will be determined by attendance and collaboratively writing up at least one lecture. Now, after your team writes up your assigned lecture, someone else or I will provide feedback in the form of (1) checking for logical errors and (2) improving mathematical clarity. You guys will then rewrite and revise and the process repeats until you have a cleanly written piece of mathematics.

Expectations: The classroom should be an open and welcoming environment. Do not be afraid to ask questions. Struggling with the material or confusion about ideas are not signs of weaknesses, but rather crucial parts of learning and growing as a mathematician. Math is hard, and the only way to overcome these difficulties is to face them head on. Be honest with yourself about whether you understand something and whenever you are confused, *please* ask me to clarify and *please* ask for help.

Course Website: Check <https://musa.berkeley.edu/math74> for course notes, course calendar, and the schedule of office hours.

Office Hours: TBD, will coincide with MUSA office hours.

Contact Information: Please email math74.berkeley@gmail.com for matters relating to the course. For more personal matters, you may email me directly at thecailanli@berkeley.edu.

Preliminary Calendar:

Week 1	1/29-2/2	Induction, Introduction to Groups, Group Tables
Week 2	2/5-2/9	Homomorphisms, Subgroups, Generators
Week 3	2/12-2/16	Metric Spaces, Limit Points, Closed sets
Week 4	2/19-2/23	Open sets, Compact Sets