

MATH 290 : MATHEMATICAL REASONING AND PROBLEM SOLVING
SYLLABUS – FALL 2021

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CONTACT INFO

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Virtual Office Hours during scheduled Discussions on Tues/Thurs, 10am-12pm PST

COURSE OVERVIEW

Preparation for reading and writing proofs with applications from major branches of mathematics, focusing on axiomatic structures and transformations that preserve structure. (4 units)

Prerequisites: Math 126 (Calculus 2) or equivalent. You should consider Math 290 to be at the same level as Math 225 and Math 226, so some experience in either of those two courses is helpful but not required.

This course serves as a primer for students going on to more advanced study in Mathematics. There will certainly be new mathematical content introduced but the content will be secondary to the **methods** we'll be using. We'll focus strongly on language, notation, the logical structure of sentences, negation, and common proof techniques. We'll talk about how to **read** proofs and advanced math textbooks in general. We'll practice **writing** proofs and **editing** them for clarity. This practice will take place mostly in groups and will usually be presented for feedback from your peers in a "writing workshop" type format. We will choose content and examples that give a light introduction to the major branches of Mathematics: Algebra, Analysis, and Topology/Geometry.

DAILY LOGISTICS

We follow all state, local, and university guidelines about meeting in person. As long as policies allow, we'll meet in [THH 118](#) each Monday/Wednesday/Friday at **1-1:50pm PST**.

At each meeting I will leave you with a short exercise or proof, due in Gradescope at **11pm PST** that day. These are very informal assignments that I'll (quickly) read myself and grade on a scale of 0-3. This provides an avenue for quick and constant feedback in both directions. Late classwork will not be accepted, but we will drop the lowest **12** scores.

Several times, especially in the beginning of the semester, we'll schedule some isolated lectures and/or discussions to be held online via **Zoom**. We must remain nimble and able to move our course online at a moment's notice.

REQUIRED SETUP

Our course will use the following online systems:

- **Blackboard** as the main hub for all communication, links, and course materials
- **Gradescope** for graded classwork and homework
- **Zoom** for occasional lectures, discussions, and office hours

You will access the latter systems through links in our Blackboard page and none of them should require separate logins. We'll work through the initial setup in our first lecture. All systems are free.

All graded assignments will be handled through the **Gradescope** link in Blackboard and you can register with the Entry Code: **YV8RZ7**.

You will need to submit your documents to Gradescope in PDF format. There are many free phone apps that you can use to scan your work, including [Adobe Scan](#) and [others](#). During the submission process you must tag each question so the grader can find it.

For all live **Zoom** sessions you will need a camera, microphone/speakers, and a stable internet connection. If any of this is an issue you can also use the [free Zoom app](#) for cell phones and tablets.

Our main reference will be [Hammack's Book of Proof](#), an excellent (and free) introduction to logic and proof structures. It is very comprehensive and we will not try to cover all its material nor will we adhere to its topic order - some classwork/homework may be drawn from this book but not all. The content of the course will be driven by the lectures, not the book.

GRADING

Classwork average	15%	
Homework average	15%	
Exam 1	10%	17 Sep 2021 (in lecture)
Exam 2	15%	13 Oct 2021 (in lecture)
Exam 3	20%	05 Nov 2021 (in lecture)
Final Exam	25%	15 Dec 2021 (11am-1pm)

LEARNING OBJECTIVES

By the end of the course, all students should:

- Have defined strategies for writing proofs using a variety of methods, including direct proofs, contradiction, contrapositive, proof by induction, and disproving statements with counterexamples.
- Understand ideas and notation around the algebra of sets, containment, cardinality, and countability.
- Be able to prove statements about relations on sets, such as divisibility in $\mathbb{N}$.
- Be able to prove statements about equivalence relations and identify equivalence classes.
- Recognize and use logical structures in sentences, including boolean operators and quantifiers.
- Have defined strategies for reading existing proofs from a variety of different sources.
- Be able to construct “counting arguments” and use combinations/permutations.
- Understand the structure of nested number systems, ending with $\mathbb{R}$.
- Understand the role of axiomatic systems, and be able to verify the defining axioms for a set; for example, the axioms of a Group or a Metric Space.
- Recognize several examples of mathematical invariants, particularly topological invariants, and use them to classify and understand mathematical structures.
- Understand functions and their properties; for example, injectivity, surjectivity, continuity, and whether or not a function preserves the mathematical structure of its domain.
- Be introduced to the style and flavor of major branches of Mathematics, including but not limited to Algebra, Analysis, and Topology.

COURSE CALENDAR

We will cover the following topics on roughly the weeks listed. The numbers on the right indicate the textbook chapters that roughly correspond to the material in question. This calendar is very tentative.

Week 01: Introductory activities on sets and mathematical language	1, 2
Week 02: Conditional statements and basic set theory	1, 2, 8, 9
Week 03: Monday Holiday. Products and relations. Drop deadline is Sep 10 (with refund).	1, 2, 8, 9, 11
Week 04: Properties of relations and partial orderings. Exam 1 on 09/17.	1, 2, 8, 9, 11
Week 05: Divisibility and arithmetic in $\mathbb{Z}$	4, 5, 7
Week 06: Modular arithmetic, groups and rings	4-9
Week 07: Equivalence relations and set constructions. Second drop deadline is Oct 08 (no refund).	4-9, 11
Week 08: Vector spaces. Exam 2 on 10/13. Fall Recess Thurs/Fri.	4-9, 11
Week 09: Proof by Induction	10
Week 10: Functions and morphisms	4-10, 12
Week 11: Cardinality. Exam 3 on 11/05.	4-10, 12, 14
Week 12: Structure of the Real Numbers. Withdrawal deadline is Nov 12 (with a W on record).	4-10
Week 13: Limits and convergence of sequences (ϵ/N proofs)	2, 13, 14
Week 14: Metric spaces. Thanksgiving Break (Wed/Thurs/Fri).	1, 13, 14
Week 15: Topological ideas in general metric spaces	4-10, 13

Finals Week is 08-15 Dec 2021. **Our final exam:** [Wednesday, 15 December, 11am-1pm PST.](#)

IMPORTANT POLICIES AND LINKS

Calculator Policy: Generally, you won't find much use for a calculator in this course. Some classroom assignments may ask you to use Wolfram Alpha or Mathematica, but these will be few and isolated. You may not use a calculator on exams.

Academic Conduct: Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. You should familiarize yourself with the [Student Conduct Code](#) and particularly with the section on [Academic Integrity](#).

Other forms of academic dishonesty are equally unacceptable. For example, see the university policies on [scientific research misconduct](#).

Counseling and Mental Health - (213) 740-9355 – 24/7 on call

studenthealth.usc.edu/counseling

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

Office of Student Accessibility Services - (213) 740-0776

osas.usc.edu

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

Any student requesting accommodations based on a disability is required to register with DSP each semester. They will provide you with a letter of verification for that semester. Please deliver this letter to me as early in the semester as possible.

Notetakers: I often have requests from DSP for well-organized students who are willing to make their class notes available to approved DSP students. The DSP Office typically pays a nominal amount to the notetaker for their trouble. If you are interested in doing this, please contact me or email DSP directly at osasNotetaking@usc.edu.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call

suicidepreventionlifeline.org

Free & confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship & Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press “0” after hours – 24/7 on call

studenthealth.usc.edu/sexual-assault

Free & confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) - (213) 740-5086 — Title IX – (213) 821-8298

equity.usc.edu, titleix.usc.edu

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298

usc-advocate.symplicity.com/care_report

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity—Title IX for appropriate investigation, supportive measures, and response.

USC Campus Support and Intervention - (213) 821-4710

campussupport.usc.edu

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101

diversity.usc.edu

Info on events, programs and training, the Provost’s Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

dps.usc.edu, emergency.usc.edu

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call

dps.usc.edu

Non-emergency assistance or information.