Math 109 Spring 2006: Mathematical Reasoning
MWF 11-11:50, WLH 2207
Professor D. Rogalski

1. Contact Information

Prof. Rogalski's Office: 5131 AP&M
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Class web site: *www.math.ucsd.edu/~drogalsk/math109.html*. Check frequently for updated homework and lecture information.
Office hours: TBA

Section Leader: John Farina, 5018 AP&M, and Oded Yacboi, 2301 AP&M
E-mail: jfarina@math.ucsd.edu, oyacobi@math.ucsd.edu
Meeting Times: M 6-6:50 (Farina), M 7-7:50 (Yacobi), HSS 2321
Office hours: TBA

2. Class Description

Math 109 is intended to prepare you for the rigorous upper-division math courses required of math majors. In it, you will learn basic techniques of proof, propositional logic and set theory. This core theory will also be applied to interesting problems in number theory and combinatorics. Learning to write good proofs does not happen overnight, or even in a single quarter, and you may find it frustrating at first. By the end of the course, the hope is you will achieve a base level of understanding of theorem proving, which you can then build on and improve in subsequent courses.

The *most* important part of the course is the homework. You cannot truly learn how to prove theorems just by watching others, but have to practice doing it yourself. Along with more straightforward problems designed to solidify the basic definitions and concepts, the homeworks will contain some problems which I expect you to find difficult. It is crucial that you begin the homework early, and work on it all week, not in a spurt. You will find that if you get stuck on a problem and come back to it later, you will usually have new ideas and insights. Mathematical writing is just a special kind of writing. You should treat your proofs as you would short essays for an English class. In particular, you should write in full sentences, with good grammar, and what you hand in should not be a first draft. Your TAs will write many comments on your assignments. They spend a lot of time giving this advice to you so you can improve, so please read their comments and think about them carefully.

The lectures are designed to focus on the concepts which I think are the most essential. The book will tend to have more information than you need, but is useful as a second source because it is helpful to see things presented at least two different ways. I will tell you when the presentation in the class differs a lot from that in the book. Some people prefer to read about a topic in the book before it is presented in lecture, while some people prefer to read the topic in the book after it is lectured on. Do whichever you find more helpful. Monday section will provide an opportunity for you to ask questions about that week's homework (due Wednesdays), to ask other general questions about the material, and to see more proofs and examples in detail. If you would like to meet with me or one of the TAs but cannot make our scheduled office hours, please make an appointment to meet at a different time.

There will be 2 in-class midterm exams on Wednesday 4/6/06 and Wednesday 5/24/06 and a final exam on Monday 6/12/06 from 11:30am-2:30pm. No makeup exams will be given. The final grades will be determined using the following breakdown: homework 25%, midterms 25%, final exam 50%. The lowest homework score will be dropped.

3. Tentative Syllabus

The following is a suggested outline of what we will cover when. This is subject to change, and updates to the schedule will be announced in class or posted on the website.

4/3/06 Introduction to course. Propositions, truth tables, connectives (1.1)
4/5 Expressions and tautologies. Introduction to basic number theory. (1.2)
4/7 Quantifiers. Direct Proofs. (1.3-1.4)

4/10 Proofs II. Proofs by contrapositive and contradiction. (1.4-1.5)
4/12 Proofs III. More number theory. (1.6)
4/14 Set theory I. Basic definitions and notation (2.1-2.2)

4/17 Set theory II. Basic theorems about sets. Proving sets are equal. (2.2)
4/19 Set theory III. Indexed families of sets. (2.3)
4/21 Proofs by Induction I. Simple examples. (3.1)

4/24 Induction II. Strong induction. Fundamental theorem of arithmetic. (3.2)
4/26 **EXAM I**.
4/28 Induction III. Inductive definition. Fibonacci numbers. (3.3)

5/1 More number theory. Euclidean algorithm. (3.4-3.5)
5/3 Cartesian product of sets. Relations. Equivalence relations I. (4.1,4.3)
5/5 Equivalence relations II. Equivalence classes, partitions. (4.3-4.4)

5/8 Congruences in number theory. (4.5)
5/10 Partial and linear orders. (4.7)
5/12 Functions I. Surjections, injections, bijections. Composition. (5.1-5.2)

5/15 Functions II. Image and inverse images. (5.6-5.7)
5/17 Combinatorics I. Permutations and combinations. (6.1)
5/19 Combinatorics II. Binomial theorem. (6.2-6.3)

5/22 Combinatorics III. Inclusion/Exclusion. (6.3)
5/24 **EXAM II**.
5/26 Countability I. Basics of cardinality (7.1)

5/29 **NO CLASS** (Memorial Day).
5/31 Countability II. Examples of countable sets. (7.4)
6/2 Countability III. Examples of uncountable sets. (7.5)

6/5 Graph Theory I. (6.4)
6/7 Graph Theory II.
6/9 Review Day.

6/12 Final exam, 11:30am–2:30pm.