Math 609 / AMCS 609: Real Analysis
Spring 2014
TTh 1:30–3:00, DRL 3C2

Philip Gressman
Office: DRL 3E5C
gressman@math.upenn.edu
Tel: (215) 898-7845

Office Hours:
Wednesdays 5:30–6:30
(±10min on colloquium days)
or by appointment

Official Course Description: Construction and properties of Lebesgue measures in Euclidean space, Borel measures and convergence theorems. Elementary function spaces. Some general measure theory, including the Caratheodory construction of measures from outer measures, the Radon-Nikodym theorem, the Fubini theorem, and Hausdorff measure. Stone Weierstrass theorem. Elements of classical harmonic analysis: the Fourier transform on basic function spaces, the Hilbert and Cauchy transforms.

This course will largely be self-contained, but for many it will be an unsuitable place to begin. You must have taken 508/509 or some equivalent:

> **MATH 508** Construction of the real numbers, the topology of the real line and the foundations of single variable calculus. Notions of convergence for sequences of functions. Basic approximation theorems for continuous functions and rigorous treatment of elementary transcendental functions. The course is intended to teach students how to read and construct rigorous formal proofs. A more theoretical course than Math 360.
>
> **MATH 509** Continuation of Math 508. The Arzela-Ascoli theorem. Introduction to the topology of metric spaces with an emphasis on higher dimensional Euclidean spaces. The contraction mapping principle. Inverse and implicit function theorems. Rigorous treatment of higher dimensional differential calculus. Introduction to Fourier analysis and asymptotic methods.

Regarding complex analysis: There will be occasions in which knowledge of the Cauchy theory of single variable complex functions will be necessary.

Useful Books: If you only procure one book for this course, it should be Real Analysis: Modern Techniques and Their Applications by Gerald B. Folland, published by Wiley-Interscience. It covers nearly all of the topics mentioned above; the chief complaints you will hear about this book are that it falls a little on the abstract side and it's somewhat dry. If you're looking for a companion text which is a little less formal and a little more readable, I recommend Measure and Integral: An Introduction to Real Analysis by Richard L. Wheeden and Antoni Zygmund, published by Marcel Dekker, Inc. It's a nice complement to Folland; it covers less material but it's more concrete.

If you're a big Stein and Shakarchi fan, you can also go that route (though they do things in a somewhat nonstandard order, so you may sometimes feel that the correspondence between lecture and text is a little stretched). The relevant books are Real Analysis: Measure Theory, Integration, and Hilbert Spaces, Functional Analysis: Introduction to Further Topics in Analysis, and Fourier Analysis: An Introduction. All are published by Princeton University Press. Real Analysis is clearly the first one to buy if you're on a budget; after that it's basically a tie for second place.

Course Website: Course materials will be posted on Canvas: <https://upenn.instructure.com>. Homework assignments will be posted on a weekly basis, usually on Thursday.

Grade System: Homework will be worth 30% of the grade. Weekly assignments are due in Eric Korman's mailbox in the math office before 3pm on Friday. Tentatively, there will be a take-home midterm due **Tuesday, March 4th** which is worth 30% of the grade as well. The final exam will be a take-home exam due **Tuesday, May 6th**; it will be worth the remaining 40% of the grade.