MATHEMATICS

10 Hillhouse Avenue, 203.432.7058
http://math.yale.edu
M.S., M.Phil., Ph.D.

Chair
Yair Minsky

Acting Chair [F]
Wilhelm Schlag

Director of Graduate Studies
Van Vu

Professors Richard Beals (Emeritus), Jeffrey Brock, Andrew Casson (Emeritus), Ronald Coifman, Igor Frenkel, Howard Garland (Emeritus), Alexander Goncharov, Roger Howe (Emeritus), Peter Jones, Richard Kenyon, Yifeng Liu, Ivan Losev, Alexander Lubotzky (Adjunct), Gregory Margulis (Emeritus), Yair Minsky, Vincent Moncrief (Physics), Andrew Neitzke, Hee Oh, Nicholas Read (Physics; Applied Physics), Vladimir Rokhlin (Computer Science), Wilhelm Schlag, George Seligman (Emeritus), Daniel Spielman (Computer Science), Van Vu, John Wettlaufer (Geology & Geophysics; Physics), Gregg Zuckerman

Assistant Professor Stefan Steinerberger

FIELDS OF STUDY
Fields include real analysis, complex analysis, functional analysis, classical and modern harmonic analysis; linear and nonlinear partial differential equations; dynamical systems and ergodic theory; probability; Kleinian groups, low dimensional topology and geometry; differential geometry; finite and infinite groups; geometric group theory; finite and infinite dimensional Lie algebras, Lie groups, and discrete subgroups; representation theory; automorphic forms, L-functions; algebraic number theory and algebraic geometry; mathematical physics, relativity; numerical analysis; combinatorics and discrete mathematics.

SPECIAL ADMISSIONS REQUIREMENT
Scores from the General Test and Mathematics Subject Test of the GRE are required.

SPECIAL REQUIREMENTS FOR THE PH.D. DEGREE
In order to qualify for the Mathematics Ph.D., all students are required to:

1. Complete eight term courses at the graduate level, at least two with Honors grades.
2. Pass qualifying examinations on their general mathematical knowledge;
3. Submit a dissertation prospectus;
4. Participate in the instruction of undergraduates;
5. Be in residence for at least three years;
6. Complete a dissertation that clearly advances understanding of the subject it considers.

All students must also complete any other Graduate School of Arts and Sciences degree requirements; see Degree Requirements under Policies and Regulations.

The normal time for completion of the Ph.D. program is five years. Requirement (1) normally includes basic courses in algebra, analysis, and topology. A sequence of three qualifying examinations (algebra and number theory, real and complex analysis, topology) is offered each term. All qualifying examinations must be passed by the end of the second year. There is no limit to the number of times that students can take the exams, and so they are encouraged to take them as soon as possible.

The thesis is expected to be independent work, done under the guidance of an adviser. This adviser should be contacted not long after the student passes the qualifying examinations. A student is admitted to candidacy after completing requirements (1)–(5) and obtaining an adviser.

In addition to all other requirements, students must successfully complete MATH 991, Ethical Conduct of Research, prior to the end of their first year of study. This requirement must be met prior to registering for a second year of study.

HONORS REQUIREMENT
Students must meet the Graduate School’s Honors requirement by the end of the fourth term of full-time study.

TEACHING
Teaching experience is integral to graduate education at Yale. Therefore, teaching is required of all graduate students, typically one term per year. (Exceptions include students with external funding and students beyond their fifth year.) Generally, first-year students work as
coaches for calculus classes, meeting with small discussion sections of undergraduates; in the first few weeks of the term, they attend a seminar that prepares them for coaching. Second-year students often work as teaching assistants for a linear algebra class (MATH 222 or MATH 225) or the accelerated calculus and linear algebra sequence (MATH 230–MATH 231); duties usually include holding office hours or leading discussion sections but not homework grading.

In the spring of their second year, graduate students attend the Lang Teaching Seminar (MATH 827). In this lunch seminar, experienced faculty help students understand the challenges of teaching and prepare students to lead their own section of calculus in the following year and beyond (differential, integral, or multivariable).

**MASTER’S DEGREES**

**M.Phil.** See Degree Requirements under Policies and Regulations.

**M.S. (en route to the Ph.D.)** A student must complete six term courses with at least one Honors grade, perform adequately on the general qualifying examination, and be in residence at least one year. The M.S. degree is conferred only en route to the Ph.D.; there is no terminal master’s degree program in Mathematics.

**COURSES**

**MATH 500a, Modern Algebra I** Ivan Loseu
A survey of algebraic constructions and theories at a sophisticated level. Topics include categorical language, free groups and other free objects in categories, general theory of rings and modules, artinian rings, and introduction to homological algebra.

**MATH 515b, Intermediate Complex Analysis** Franco Vargas Pallete
Topics may include argument principle, Rouché’s theorem, Hurwitz theorem, Runge’s theorem, analytic continuation, Schwarz reflection principle, Jensen’s formula, infinite products, Weierstrass theorem; functions of finite order, Hadamard’s theorem, meromorphic functions; Mittag-Leffler’s theorem, subharmonic functions.

**MATH 520a, Measure Theory and Integration** Arie Levit
Construction and limit theorems for measures and integrals on general spaces; product measures; Lp spaces; integral representation of linear functionals.

**MATH 525b, Introduction to Functional Analysis** Jeremy Hoskins
Hilbert, normed, and Banach spaces; geometry of Hilbert space, Riesz-Fischer theorem; dual space; Hahn-Banach theorem; Riesz representation theorems; linear operators; Baire category theorem; uniform boundedness, open mapping, and closed graph theorems. After MATH 520.

**MATH 544a, Introduction to Algebraic Topology I** Staff
A one-term graduate introductory course in algebraic topology. We discuss algebraic and combinatorial tools used by topologists to encode information about topological spaces. Broadly speaking, we study the fundamental group of a space, its homology, and its cohomology. While focusing on the basic properties of these invariants, methods of computation, and many examples, we also see applications toward proving classical results. These include the Brouwer fixed-point theorem, the Jordan curve theorem, Poincaré duality, and others. The main text is Allen Hatcher’s *Algebraic Topology*, which is available for free on his website.

**MATH 545b, Introduction to Algebraic Topology II** Staff

**MATH 827b, Lang Teaching Seminar** Marketa Havlickova
This course prepares graduate students for teaching calculus classes. It is a mix of theory and practice, with topics such as preparing classes, presenting new concepts, choosing examples, encouraging student participation, grading fairly and effectively, implementing active learning strategies, and giving and receiving feedback. Open only to mathematics graduate students in their second year.

**MATH 991a / CPSC 991a, Ethical Conduct of Research** Staff

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