APPLIED MATHEMATICS

A. K. Watson Hall, 203.432.1278
http://applied.math.yale.edu
M.S., M.Phil., Ph.D.

Director of Graduate Studies
Vladimir Rokhlin

Professors Andrew Barron (Statistics & Data Science), Joseph Chang (Statistics & Data Science), Ronald Coifman (Mathematics; Computer Science), Stanley Eisenstat (Computer Science), John Emerson (Adjunct; Statistics & Data Science), Michael Fischer (Computer Science), Jonathon Howard (Molecular Biophysics & Biochemistry), Peter Jones (Mathematics), Yuval Kluger (Pathology), Nicholas Read (Physics; Applied Physics; Mathematics), Vladimir Rokhlin (Computer Science; Mathematics), Wilhelm Schlag (Mathematics), Martin Schultz (Emeritus, Computer Science), Mitchell Smooke (Mechanical Engineering & Materials Science; Applied Physics), Daniel Spielman (Computer Science; Mathematics), Van Vu (Mathematics), Günter Wagner (Ecology & Evolutionary Biology), John Wettlaufer (Geology & Geophysics; Mathematics; Physics), Huibin Zhou (Statistics & Data Science), Steven Zucker (Computer Science; Biomedical Engineering)

Associate Professors Thierry Emonet (Molecular, Cellular, & Developmental Biology; Physics), Josephine Hoh (Public Health), Sekhar Tatikonda (Statistics & Data Science)

Assistant Professors Smita Krishnaswamy (Genetics; Computer Science), Roy Lederman (Statistics & Data Science)

FIELDS OF STUDY
The graduate Program in Applied Mathematics comprises the study and application of mathematics to problems motivated by a wide range of application domains. Areas of concentration include the analysis of data in very high-dimensional spaces, the geometry of information, computational biology, and randomized algorithms. Topics covered by the program include classical and modern applied harmonic analysis, linear and nonlinear partial differential equations, numerical analysis, scientific computing and applications, discrete algorithms, combinatorics and combinatorial optimization, graph algorithms, geometric algorithms, discrete mathematics and applications, cryptography, statistical theory and applications, probability theory and applications, information theory, econometrics, financial mathematics, statistical computing, and applications of mathematical and computational techniques to fluid mechanics, combustion, and other scientific and engineering problems.

SPECIAL ADMISSIONS REQUIREMENTS
All applicants are required to submit official scores from the GRE General Test.

SPECIAL REQUIREMENTS FOR THE PH.D. DEGREE
All students are required to: (1) complete twelve term courses (including reading courses) at the graduate level, at least two with Honors grades; (2) pass a qualifying examination on their general applied mathematical knowledge (in algebra, analysis, and probability and statistics) by the end of their second year; (3) submit a dissertation prospectus; (4) participate in the instruction of undergraduates; (5) be in residence for at least three years; and (6) complete a dissertation that clearly advances understanding of the subject it considers. Prior to registering for a second year of study, and in addition to all other academic requirements, students must successfully complete MATH 991, Ethical Conduct of Research, or another approved course on responsible conduct in research. Teaching is considered an integral part of training at Yale University, so all students are expected to complete two terms of teaching within their first two years. Students whose advisers experience disruption in funding may require additional support from the Graduate School. In such cases, students will be required to teach additional terms, if needed, after they have fulfilled the academic teaching requirement.

Requirement (1) normally includes four core courses in each of the methods of applied analysis, numerical computation, algorithms, and probability; these should be taken during the first year. The qualifying examination is normally taken by the end of the third term and will test knowledge of the core courses as well as more specialized topics. The thesis is expected to be independent work, done under the guidance of an adviser. An adviser is usually contacted not long after the student passes the qualifying examinations; students are encouraged to find an adviser sooner rather than later. A student is admitted to candidacy after completing requirements (1)–(5) and finding an adviser.

In addition to the above, all first-year students must successfully complete one course on the responsible conduct of research (e.g., MATH 991 or CPSC 991) and AMTH 525, Seminar in Applied Mathematics.

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

M.D./PH.D. STUDENTS
With permission of the DGS, M.D./Ph.D. students may request a reduction in the program’s academic teaching requirement to one term of teaching. Only students who teach are eligible to receive a University stipend contingent on teaching.
MASTER’S DEGREES

M.Phil. The minimum requirements for this degree are that a student shall have completed all requirements for the Applied Math Ph.D. program as described above except the required teaching, the prospectus, and the dissertation. Students will not generally have satisfied the requirements for the M.Phil. until after two years of study, except where graduate work done before admission to Yale has reduced the student’s graduate course work at Yale. In no case will the degree be awarded after less than one year of residence in the Yale Graduate School of Arts and Sciences. See also Degree Requirements under Policies and Regulations.

M.S. (en route to the Ph.D.) Applications for a terminal master’s degree are not accepted. Students who withdraw from the Ph.D. program may be eligible for the M.S. degree if they have completed ten graduate-level term courses, maintained a High Pass average, and met the Graduate School’s Honors requirement for the Ph.D. program. Students who are eligible for or who have already received the M.Phil. will not be awarded the M.S.

More information is available on the program’s website, http://applied.math.yale.edu.

COURSES

AMTH 500b, Spectral Graph Theory & Apps  Vladimir Rokhlin

AMTH 511b, Topics in Algorithms  Jeremy Hoskins

AMTH 525a or b, Seminar in Applied Mathematics  Peter Jones
This course consists of weekly seminar talks given by a wide range of speakers. Required of all first-year students.

AMTH 561a or b / CPSC 662a or b, Spectral Graph Theory  Daniel Spielman
An applied approach to spectral graph theory. The combinatorial meaning of the eigenvalues and eigenvectors of matrices associated with graphs. Applications to optimization, numerical linear algebra, error-correcting codes, computational biology, and the discovery of graph structure.

AMTH 610b, Numerical Analysis  Vladimir Rokhlin

AMTH 663b / CPSC 663b, Deep Learning Theory and Applications  Smita Krishnaswamy
Deep neural networks have gained immense popularity in the past decade due to their outstanding success in many important machine-learning tasks such as image recognition, speech recognition, and natural language processing. This course provides a principled and hands-on approach to deep learning with neural networks. Students master the principles and practices underlying neural networks, including modern methods of deep learning, and apply deep learning methods to real-world problems including image recognition, natural language processing, and biomedical applications. Course work includes homework and a final project—either group or individual, depending on the total number enrolled—with both a written and oral (i.e., presentation) component.

AMTH 765b / CB&B 562b / ENAS 561b / INP 562b / MB&B 562b / MCDB 562b / PHYS 562b, Modeling Biological Systems II  Damon Clark, Thierry Emonet, and Jonathon Howard
This course covers advanced topics in computational biology. How do cells compute, how do they count and tell time, how do they oscillate and generate spatial patterns? Topics include time-dependent dynamics in regulatory, signal-transduction, and neuronal networks; fluctuations, growth, and form; mechanics of cell shape and motion; spatially heterogeneous processes; diffusion. This year, the course spends roughly half its time on mechanical systems at the cellular and tissue level, and half on models of neurons and neural systems in computational neuroscience. Prerequisite: a 200-level biology course or permission of the instructor.