MATHEMATICS, PHD

Contact

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Faculty

Uday Banerjee, Pinyuen Chen, Dan Coman, Steven Diaz, Shukai Du, Nicole L. Fonger, Pierre Yves Gaudreau Lamarre, Jack E. Graver, Duane Graysay, Pawel Grzegrzolka, Thomas John, Lee Kennard, H. Hyune-Ju Kim, Leonid Kovalev, Graham J. Leuschke, Wei Li, Jianxuan Liu, Adam Lutoborski, Rachana Maharjan, Joanna O. Masingila, Moira McDermott, Jeffrey Meyer, Claudia Miller, Jani Onninen, Josh Pollitz, Declan Quinn, Hamidreza Rahmati, Lixin Shen, Gregory Verchota, Stephan Wehrli, William Wylie, Yiming Zhao

The Department of Mathematics has 33 faculty members, with research interests in several areas of mathematics, statistics, and mathematics education, and approximately 55 graduate students. The department is housed in the recently renovated Carnegie Library building on the main campus quadrangle. Programs of study include those for M.S. and Ph.D. degrees in Mathematics, with or without a concentration in Statistics, and for M.S. and Ph.D. degrees in Mathematics Education.

The Ph.D. degree in mathematics is the primary graduate degree offered by the Mathematics Department. Successful applicants are admitted directly to the Ph.D. program and earn a M.S. degree on the way to their Ph.D.

Research Areas

The department's Colloquium series features weekly lectures by mathematicians from all over the United States and abroad in many of the areas of mathematical research represented in the department. Furthermore several of the research groups organize regular research seminars. Colloquia and seminar schedules, along with other information about our programs, courses, and events, can be found at: artsandsciences.syracuse.edu/mathematics/ (https://artsandsciences.syracuse.edu/mathematics/).

The following research groups are currently represented in the department.

Algebra

Algebraic geometry (moduli spaces of curves, equations defining finite sets of points), commutative algebra (homological algebra, Cohen-Macaulay modules, characteristic p), non-commutative algebra (representations of finite-dimensional algebras, homological algebra, group actions on non-commutative rings, Hopf algebras, enveloping algebras, non-commutative algebraic geometry). Faculty: Diaz, Leuschke, Miller, Pollitz, Quinn

Analysis

Complex analysis (several complex variables, pluripotential theory, complex dynamics, invariant metrics, holomorphic currents, Kähler geometry, rigidity problems), geometric analysis (PDE on manifolds, geometric flows), harmonic analysis, partial differential equations (linear and nonlinear elliptic PDE, boundary value problems on nonsmooth domains), geometric function theory (quasiconformal mappings, analysis on metric spaces). Faculty: Coman, Kovalev, Onninen, Verchota, Wylie, Zhao

Applied Mathematics

Numerical analysis (approximate solutions of elliptic PDE, generalized finite element methods and meshless methods), nonlinear variational problems (microstructure in nonlinear elasticity), applied and computational harmonic analysis (wavelets, digital image processing), numerical linear algebra, scientific machine learning. Faculty: Banerjee, Du, Lutoborski, Shen

Combinatorics

Combinatorics, graph theory, rigidity theory, symmetries of planar graphs, automorphism groups of graphs. Faculty: Graver

Geometry/Topology

Low-dimensional topology and knot theory (knot concordance, Heegaard Floer homology, homology theories for knots and links), Riemannian/Kähler geometry (curvature and topology, symmetry, special metrics, geometric flows, rigidity problems), convex geometry (Minkowski problems, sharp isoperimetric inequalities). Faculty: Kennard, Wehrli, Wylie, Zhao

Mathematics Education

Secondary mathematics education, teacher learning, mathematical representations, out-of-school mathematics practice, teacher development. Faculty: Fonger, Graysay, Masingila

Probability

Probability theory, functional analysis, and mathematical physics; Random Schrödinger operations, stochastic partial differential equations, random matrices, and free probability. Faculty: Gaudreau Lamarre, Ko

Statistics

Ranking and selection theory with applications in signal processing and multistage clinical trials, change-point problems with applications in cancer trend analysis, sequential analysis, nonparametric and semiparametric statistics, Bayesian inference, causal inference, measurement error models, high-dimensional data analysis. Faculty: Chen, Kim, Ko, Li, Liu

Graduate Awards

Graduate Scholarships

Support graduate study for students with superior qualifications; provide, in most cases, full tuition for the academic year.

Graduate Assistantships

Offered to most Graduate Scholarship recipients; no more than an average of 20 hours of work per week; nine months; stipend in addition to tuition scholarship for 24 credits per year. Additional summer support is generally available.

Syracuse University Graduate Fellowships

Tax-free stipends for nine months of full-time study; tuition scholarship for 15 credits per semester for a total of 30 credits during the academic year.

Facilities

The mathematics collection is held within the Carnegie Library and supports mathematical research over a broad range of pure and applied mathematics, as well as mathematics education, mathematical statistics, and interdisciplinary areas. Most of the non-book resources are online and include an extensive collection of databases and journals supporting the mathematical sciences. In addition, the library provides a growing collection of ebooks.

Students may borrow course reserved textbooks, laptops, TI graphing calculators, and geometry kits from the Carnegie Library service desk. Students may also reserve one of three group study rooms located on the first floor of the library. A computer lab in the library provides software for programming, statistical and data analysis, video and multimedia, and access to printers.

Carnegie Library is home to collections in the sciences, including engineering and computer science, the life sciences, and the physical sciences and hosts a strong collection of databases, journals, and ebooks supporting all disciplines. The historic Reading Room gives the library a distinctive ambience and provides a quiet place for students to study.

Student Learning Outcomes

1. Demonstrate mastery in the core areas of algebra/topology and analysis by solving problems using advanced techniques
2. Demonstrate advanced knowledge in their chosen specialty and in an additional area of mathematics by solving problems using advanced techniques
3. Plan and successfully conduct original research, producing results worthy of publication in peer reviewed journals
4. Effectively communicate mathematical ideas

Ph.D. in Mathematics

General Requirements

All the candidates for the Ph.D. Degree in mathematics must satisfy the same general requirements. They are:

1. Completion of the requirements for the Masters' degree in mathematics via the mathematics track.
2. Completion of a total of at least 72 credits of graduate course work, including credits taken toward the completion of the MS degree. Credits beyond the MS degree must be at the 600-level or above. Up to 24 credits may be dissertation credits. Dissertation credits can be taken only after students pass the full Qualifying Examinations.
3. Maintaining grade point average of at least 3.6 in the courses covered by the Preliminary and Qualifying Examinations and in the courses in their field of specialization. The Mathematics Graduate Committee may recommend that a student in the Ph.D. program who fails to maintain the required grade point average not be continued in the Ph.D. program.

The Preliminary Examination Requirement

The preliminary examination covers two of the three foundational course sequences, MAT 601 Fundamentals of Analysis I- MAT 602 Fundamentals of Analysis II, MAT 631 Introduction to Algebra I- MAT 632 Introduction to Algebra II, and MAT 651 Probability and Statistics I- MAT 652 Probability and Statistics II. It consists of four 2-hour written examinations, two over each sequence. These exams are given as the comprehensive final exams at the end of each semester. The possible outcomes for each exam are Pass, Superior Pass, and Fail. Students must receive three grades of Superior Pass and one Pass or Superior Pass, in the four exams covering two sequences. In each of the four courses, the course grade and the outcome of the Preliminary Examination are two separate decisions.

Students who wish to continue in the Ph.D. program must pass these examinations before their second year of graduate study. Only two attempts at each of these examinations are permitted. A second try at each exam will be offered in August before the student's second year. The exact date will be announced at least a month ahead of time.

Students who enter the Mathematics Graduate Program with extensive preparation in mathematics may attempt the Preliminary Examinations upon entering the Program. This attempt will not be counted as one of the two attempts at the Preliminary Examinations.

Students may petition the Mathematics Graduate Committee to postpone completion of the preliminary examination requirement until before their third year of graduate study.

Course Requirements in the Mathematics Option

Students following the mathematics option to the Ph.D. Degree in Mathematics are required to:

1. Complete two breadth courses in each of algebra/topology and analysis. The choices of breadth courses in these areas are:
   a. Algebra/Topology - MAT 661 Introduction to Topology and either MAT 761 Introduction to Algebraic Topology or MAT 731 Rings and Modules
   b. Analysis - MAT 701 Real Variables I and either MAT 712 Functions of a Complex Variable I or MAT 721 Probability I
2. Complete three additional mathematics courses numbered 700 or above. These courses may not include reading courses or courses taken to satisfy earlier requirements.

Course Requirements in the Mathematics With an Emphasis in Statistics Option

Students following the option in mathematics with an emphasis in statistics leading to the Ph.D. Degree in Mathematics are required to:

1. Complete two breadth courses in each of analysis and statistics.
   a. Analysis - MAT 701 Real Variables I and either MAT 712 Functions of a Complex Variable I or MAT 721 Probability I
   b. Statistics - MAT 651 Probability and Statistics I - MAT 652 Probability and Statistics II or MAT 653 Statistical Simulation and Nonstandard Data Analysis - MAT 654 Linear Models
2. Complete either MAT 682 Numerical Linear Algebra or MAT 683 Methods of Numerical Analysis I.
3. Complete three additional mathematics courses numbered 600 or above. These courses may not include reading courses or courses taken to satisfy earlier requirements. These courses must be approved by the student's Ph.D. advisor and the Graduate Committee.
4. Complete one course in applied statistics taken from a list of courses not offered by the Mathematics Department but approved by the Graduate Committee.

Code	Title	Credits
APM 625		3
MAS 766	Linear Statistical Models I: Regression Models	3

MAS 777	Time Series Modeling and Analysis	3
PSY 853	Experimental Design and Statistical Tests	3
PSY 854	Bayesian Statistical Analysis	3
PSY 857	Multivariate Analysis	3

The Qualifying Examination Requirement

The Qualifying Examination consists of two written tests, each covering one of the following two-course sequences.

Code	Title	Credits
Algebra		
MAT 731 & MAT 732	Rings and Modules and Homological Algebra	6
Analysis I		
MAT 701 & MAT 712	Real Variables I and Functions of a Complex Variable I	6
Analysis II		
MAT 701 & MAT 721	Real Variables I and Probability I	6
Combinatorics		
MAT 645 & MAT 646	Graph Theory and Enumeration, Designs, and Matroids	6
Numerical Analysis		
MAT 683 & MAT 684	Methods of Numerical Analysis I and Methods of Numerical Analysis II	6
Statistics		
MAT 654 & MAT 755	Linear Models and Multivariate Statistical Analysis	6
Topology		
MAT 661 & MAT 761	Introduction to Topology and Introduction to Algebraic Topology	6

Note:
The student should choose the qualifying exams in consultation with their anticipated Ph.D. advisor. The approved combinations for the two qualifying exams are:

- Applied Math: Numerical Analysis and Analysis I
- Statistics: Statistics and Analysis II
- Pure Math: Any combination of Algebra, Analysis I, Analysis II, Combinatorics, and Topology such that the course sequences are disjoint.

Each part of the Qualifying Examination lasts four hours. The parts may be taken separately. There are only two outcomes on each part, Pass or Fail. These examinations will be given twice a year, before or near the beginning of each semester. The exact dates will be announced at least a month ahead of time.

Students must either pass the coursework on which a Qualifying Exam is based before taking it, or petition the Graduate Committee. Students should take the qualifying exam as soon as possible after finishing the corresponding coursework. Students must pass one qualifying exam by the August preceding their fourth year of graduate study and pass both exams no later than January during their fourth year of graduate study.

With the approval of the Mathematics Graduate Committee, students who postpone taking one or both of their Preliminary Examinations until their third year of graduate study may also postpone the Qualifying Examinations, in the same area, until their fourth year of graduate study.

The Language Requirement

All students must demonstrate mastery of English. Generally, admission to graduate study implies proficiency in English, but in some cases, as determined by the chair, associate chair, or by the student's advisor, remedial work may be required.

The Dissertation Requirement

The most important part of the Ph.D. program is the writing of a dissertation that demonstrates the candidate's ability to carry out an independent investigation that makes an original, scholarly contribution to mathematics.

Each Ph.D. candidate has a dissertation advisor who provides guidance in the final part of the course program and during the writing of the dissertation. A student should discuss this program with the dissertation advisor each semester before meeting with an academic advisor as part of registration.

The Oral Examination (Dissertation Defense) Requirement

When the dissertation meets with the approval of the student's dissertation advisor and the student has acquired a total of 72 hours of graduate credit, the candidate is given a final oral examination of the dissertation and the immediately related field. The committee for this examination will consist of a chair appointed by the Graduate School, the student's dissertation advisor, and four other members appointed by the Mathematics Graduate Committee with advice from the student and the dissertation advisor. Upon final approval of this committee, a copy of the dissertation will be placed in the mathematics library.