

MATHEMATICS AND STATISTICS

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FACULTY

Alberto Baidar, Professor; PhD, MIT; Partial Differential Equations, Numerical Analysis

Martin Bendersky, Professor; PhD, California (Berkeley); Algebraic Topology

Edward S. Binkowski, Associate Professor; PhD, Princeton; Data Analysis

Barry M. Cherkas, Professor; PhD, Georgetown; Partial Differential Equations

Daniel S. Chess, Associate Professor; PhD, Princeton; Structure Theorems for Diffeomorphisms

Richard C. Churchill, Professor; PhD, Wisconsin; Dynamical Systems

Sandra P. Clarkson, Professor; EdD, Georgia; Mathematics Education

Lucille Croom, Professor; PhD, Columbia; Mathematics Education

Thomas F. Jambois, Associate Professor; PhD, California (Berkeley); Riemann Surfaces, Algebraic Geometry

John Loustau, Professor; PhD, California (Santa Barbara); Non-associative Algebras, Computer Graphics

Jane Matthews, Associate Professor; PhD, NYU; Group Theory

Ada Peluso, Professor; PhD, NYU; Group Theory

Joseph Roitberg, Professor; PhD, NYU; Algebraic Topology

Verna Segarra, Lecturer; MA, City College; Mathematics Education

Brian Shay, Associate Professor; PhD, CUNY; Algebraic Topology

Lev Shneyerson, Associate Professor; PhD, Ural State University; Semigroup Theory

Mary Small, Lecturer; MA, Teachers College, Columbia; Mathematics Education

Robert D. Thompson, Professor; PhD, Washington; Algebraic Topology

William H. Williams, Professor; PhD, Iowa State; Sampling Theory, Time Series, Econometrics

teaching is designed for individuals without provisional certification in mathematics. Individuals who already have provisional certification in mathematics should pursue either the MA in pure mathematics or the MA in statistics and applied mathematics.

MASTER OF ARTS — PURE MATHEMATICS PROGRAM

Requirements for Admission

In addition to the general college requirements for admission, students must meet the following departmental requirements: at least 24 acceptable credits in mathematics with a B average in the courses involved. (In special cases, students who show evidence of unusual mathematical ability, but who do not meet both of the above requirements, will be considered.) See Undergraduate Catalog, p. 114 for major requirements and list of courses.

Requirements for Degree

Thirty credits from courses chosen as follows:

1. **MATH 721-722** (Modern Algebra I and II), or **MATH 725** (Linear Algebra) and **STAT 722** (Theory of Games).
2. **MATH 746-747** (Theory of Functions of a Real Variable I and II).
3. **MATH 742** (Theory of Functions of a Complex Variable).
4. **MATH 751** (General Topology).
5. At least 6 credits chosen from courses at the **MATH 700** and/or **STAT 700** level.

Degrees Offered

HEGIS

Mathematics	BA*	1701
Mathematics Teaching	BA*	1701
Statistics	BA*	1702
Pure Mathematics	MA	1701
Statistics and Applied Mathematics	MA	1703
Mathematics Teaching (7–12)	MA	1701
Mathematics or Statistics & Applied Mathematics	BA/MA	1701
Mathematics Teaching (7–12)	BA/MA	1701

* See Hunter College Undergraduate Catalog 2002-2004, p. 114, for information concerning undergraduate programs in mathematics and statistics.

6. Six credits at most from courses at the **MATH 600** and/or **STAT 600** level or from approved courses in another department.
7. Written comprehensive examination covering the courses listed in items 1 and 2 above, and in two additional areas.
8. Reading knowledge of French, German, Russian, or other language with a sufficiently rich mathematical literature.

MASTER OF ARTS — STATISTICS AND APPLIED MATHEMATICS PROGRAM

Requirements for Admission

The general college admission requirements must be satisfied. The department's requirements are minimal in order to encourage all those who may have the mathematical maturity to handle the program to apply. Some students, however, may only be accepted into the program conditionally, contingent upon their successful completion of **MATH 351/641** (Mathematical Analysis I) and **MATH 260** (Linear Algebra). Hence, irrespective of past specialization, the only requirement for entrance into the program is an adequate undergraduate record, one semester of advanced calculus, and one semester of linear algebra.

The Department of Mathematics and Statistics offers a choice of master's programs. The masters in pure mathematics is intended primarily for students interested in studying mathematics on a broad scale. This program is used by students as preparation for industrial and academic employment, and as preparation for further graduate study. The program in statistics and applied mathematics is intended for students interested in applications to business, science, engineering, and industry, as well as teaching and research. In addition, the department offers, jointly with the School of Education, a master of arts in teaching, and a combined BA/MA in mathematics teaching. The MA in mathematics



Requirements for Degree

Thirty credits from courses chosen as follows:

1. **STAT 720, 721** (Probability).
2. **STAT 711, 712** (Statistical Decision Theory).
3. Fifteen credits in statistics, computer science, mathematics, or relevant areas of application, selected to constitute a cohesive program. Typically, these courses are at the **MATH 700** and/or **STAT 700** level.
4. **STAT 790** (Case Seminar). The student, guided by a member of the faculty, prepares a project in statistics or applied mathematics. This replaces the comprehensive examination requirement. Students may elect to fulfill this requirement by taking **MATH 777**, subject to the approval of the graduate adviser.

The student must exhibit a working knowledge of two useful computer languages. This replaces the foreign language requirement.

PROGRAM FOR TEACHERS OF ADOLESCENCE EDUCATION (Grades 7–12) — MATHEMATICS MA

Two program sequences are available for the preparation of teachers of mathematics in grades 7–12, each of them designed for a different group of students. Track I is a 37–39 credit MA designed for individuals who have completed an undergraduate major in mathematics but have little or no background in teacher education. Track II is a 34.5–38 credit MA program designed for individuals who have certification in an area other than mathematics and are currently teaching mathematics in grades 7–12. A BA/MA program of at least 141 credits is also offered; this program is described in the undergraduate catalog p 115 and in this catalog (see below).

Track I: MA in Teaching

37-39 credits

Requirements for Admission

1. 24 or more credits in mathematics approved by the graduate mathematics adviser, including a course in elementary statistics, a year of calculus, and a course in matrix algebra or linear algebra.
2. An overall grade point average of 2.8 or better in undergraduate work.
3. An average of at least 2.7 in mathematics courses.
4. A general education core in the liberal arts and sciences to include the following in addition to math: 6 credits in English, 6 credits in a language other than English, 6 credits in social studies (to include at least one course in U.S. history or geography), 6 credits in the arts, and 6 credits in science.*

Applicants who have an overall GPA between 2.5 and 2.79 and meet all other requirements for matriculation may be considered for admission to nonmatriculant status. Only students who demonstrate strong verbal skills in addi-

tion to other indices of ability to do graduate work will be admitted as nonmatriculants. Applicants will be required to provide an on-site writing sample (essay) and participate in a face-to-face interview. Academically relevant data, such as scores on the General Aptitude Test of the Graduate Record Exam or on the Liberal Arts and Sciences Test of the NYS Teacher Certification examination, may also be submitted in support of admission.

See the School of Education section of this catalog for additional information on admission, progress standards, and exit criteria.

Course Sequences:

Education: 22-24 credits

See School of Education section of the catalog for specification of courses.

Mathematics: 15 credits

MATH 620	3 cr
Sequential Mathematics from an Advanced Standpoint I	
MATH 630	3 cr
Sequential Mathematics from an Advanced Standpoint II	
MATH 640**	3 cr
Topics in Calculus	
MATH 661***	3 cr
History of Mathematics	
STAT 614***	3 cr

Comprehensive Examination

The comprehensive examination will have two parts: one part will deal with mathematics, the other part with pedagogy.

** Students may be admitted lacking up to 12 credits of courses required for admission. Students must fulfill these conditions within their first three semesters of matriculation. Courses taken to fulfill conditions do not count toward the master's degree.*

*** Required unless a student has had both multivariate calculus and experience with calculus using graphing calculators and computer packages such as MAPLE and MATHEMATICA. Students who do not need to take this course may substitute another 3-credit course or two seminars of 1.5 credits each with approval of the graduate adviser.*

**** With approval of the graduate mathematics adviser, students who have had substantial coverage of a given area within an undergraduate curriculum may be allowed to replace a course or courses in this category with electives, preferably elective courses at a more advanced level in the same area.*

Track II: MA in Teaching

34.5-38 Credits

Requirements for Admission

1. At least 18 credits in mathematics approved by the graduate mathematics adviser, including a course in elementary statistics, a year of calculus, and a course in matrix algebra or linear algebra.

2. An overall grade point average of 2.8 or better in undergraduate studies.
3. An average of at least 2.7 in mathematics courses.
4. NYS initial or provisional teacher certification in an area other than mathematics and assignment as a teacher of mathematics in grades 7–12.

See the School of Education section of this catalog for additional information on admission, progress standards, and exit criteria.

Course Sequences:

Education: 9-11 credits

See School of Education section of the catalog for specification of courses.

Mathematics: 25.5-27 credits

Core: 6 credits

MATH 620	3 cr
Sequential Mathematics from an Advanced Standpoint I	
MATH 630	3 cr
Sequential Mathematics from an Advanced Standpoint II	

Additional Core: 3 credits

MATH 640*	3 cr
Topics in Calculus	

Other Required Areas**

MATH 621	3 cr
Introduction to Abstract Algebra	
MATH 623	3 cr
Theory of Numbers	
MATH 661	3 cr
History of Mathematics	
STAT 614	3 cr
Data Analysis Using Statistical software	

Electives: 4.5-6 credits

Courses in mathematics and statistics (1.5 or 3 credits) or in such areas as computer science, with the approval of the graduate mathematics adviser.

Comprehensive Examination

The comprehensive examination will have two parts: one part will deal with mathematics, the other part with pedagogy.

** Required unless a student has had both multivariate calculus and experience with calculus using graphing calculators and computer packages such as MAPLE and MATHEMATICA. Students who do not need to take this course may substitute another 3-credit course or two seminars of 1.5 credits each with approval of the graduate adviser.*

*** With approval of the graduate mathematics adviser, students who have had substantial coverage of a given area within an undergraduate curriculum may be allowed to replace a course or courses in this category with electives, preferably elective courses at a more advanced level in the same area.*

MATHEMATICS or STATISTICS AND APPLIED MATHEMATICS BA/MA

The BA/MA program offers promising students the opportunity to complete both the bachelor's and master's degree requirements with a minimum of 120 credits. Requirements are the same as those for a major in the department, plus 30 credits at the graduate level. Interested students should contact the departmental graduate adviser for further information regarding eligibility and curriculum requirements.

Option 1: Accelerated BA/MA Program in Mathematics

Students complete the BA in pure mathematics with 30 additional credits at the graduate level in pure mathematics approved by the departmental graduate adviser.

Option 2: Accelerated BA/MA Program in Statistics and Applied Mathematics

Students complete the BA in statistics or mathematics with 30 additional credits at the graduate level in applied mathematics, statistics and computer science approved by the departmental graduate adviser.

PREPARATION FOR ADOLESCENCE EDUCATION (Grades 7–12) BA/MA

Students interested in teaching grades 7–12 may pursue a combined BA/MA program in teaching. This program requires a minimum of 141 credits.

Admission Requirements

1. Completion of at least 45 credits with a GPA of 2.8
2. Completion of at least 10 credits in mathematics, including a year of calculus (**MATH 150** and **155** or equivalent), with an average of 2.7 in these major courses.

Degree Requirements

The BA/MA program includes 46 credits in mathematics and 22-24 credits in teacher education courses, some of them taken at the undergraduate level and some at the graduate level. The required mathematics courses of the BA/MA in the teaching of mathematics are:

1. **MATH 150** and **155** (or the equivalent), **250**, **260** and **311** (or the equivalent), **620**, **623**, **630**, **661**, and **STAT 720** (or the equivalent),
2. 12 additional credits at the 300 level or above, with at least half at the graduate level, selected with the approval of the departmental adviser.

COURSE LISTINGS

Each course 45 hours, 3 cr unless otherwise noted

PURE MATHEMATICS

MATH 601 Mathematical Methods for the Physical Sciences

Topics include: Fourier Series, Sturm-Liouville theory, Green functions, and eigenfunction expansions. These will be applied to the heat, wave, Laplace, and one-dimensional Schrodinger equations.

prereq: a course in ordinary differential equations

MATH 620 Sequential Mathematics from an Advanced Standpoint I

Study, from an advanced standpoint, of the mathematics involved in the new sequential mathematics high school curriculum, with special focus on algebra, geometry, and statistics.

prereq: a course in ordinary differential equations

MATH 621 Introduction to Abstract Algebra

Introduction to the theory of groups and rings.

prereq: a course in linear algebra

MATH 622 Further Topics in Advanced Abstract Algebra

Elements of Galois theory, construction with ruler and compass, advanced topics in ring theory and linear algebra.

prereq: a course in introductory abstract algebra

MATH 623 Theory of Numbers

Congruences, quadratic residues, elementary diophantine analysis, continued fractions, sums of squares.

prereq: a course in linear algebra

MATH 630 Sequential Mathematics from an Advanced Standpoint II

Study, from an advanced standpoint, of the mathematics involved in the new sequential mathematics high school curriculum, with specific focus on geometry, and both algebraic and transcendental functions. Open only to Teacher Education Program students.

MATH 634 Geometries I

Topics in affine and projective geometry and/or topics in differential geometry.

prereq: a course in linear algebra

MATH 640 Topics in Calculus

Topics in single and multi-variable calculus examined from an advanced standpoint and incorporating use of graphing calculators and such computer packages as MAPLE and MATHEMATICA.

prereq: MATH 630. Open only to Teacher Education Program students.

MATH 641 Mathematical Analysis I

Mature consideration of theory and processes of calculus, including the Heine-Borel and Bolzano-Weierstrass Theorems.

prereq: MATH 260 and either MATH 254 or 255.

MATH 642 Introduction to Theory of Functions of a Complex Variable

Complex numbers, analytic functions, elementary functions, contour integrals, Cauchy integral theory, series.

prereq: a course in advanced calculus

MATH 645 Mathematical Analysis II

Continuation of **MATH 641** with an emphasis on functions of several variables.

prereq: MATH 641

MATH 653 Calculus on Manifolds

Functions on Euclidean space, implicit function theorem, Fubini's Theorem, integration on chains and manifolds.

prereq: a course in advanced calculus

MATH 654 Dynamical Systems and Chaos

Topics include: flows in one and two dimensions; phase portraits; limit cycles; bifurcations; iterated maps on the interval; introduction to chaos and fractals; the Mandelbrot set and its significance.

prereq: a course in multivariate calculus and a course in linear algebra
Familiarity with MAPLE or MATHEMATICA encouraged

MATH 661 History of Mathematics

Survey of the history of mathematics and statistics to the present including roots in non-Western culture and contributions of women and minorities.

MATH 671 Fundamental Concepts of Modern Mathematics

An axiomatic approach to theory of sets; axiom of choice, Zorn's Lemma, transfinite arithmetic.

prereq: any 2 courses chosen from linear algebra, modern algebra, or advanced calculus I and II

MATH 672 Mathematical Logic

A survey of the central results and techniques of metalogic, principally mathematical induction, the soundness and completeness of theorems for first-order logic, the Skolem Theorem; and Church's Theorem on undecidability.

prereq: a course in linear algebra or permission of instructor

MATH 685 Numerical Methods I

Accuracy and precision, convergence, iterative and direct methods. Topics selected from: solution of polynomial equations and linear systems of equations; curve fitting and function approximation; interpolation; differentiation and integration; differential equations.

Note: Cross-listed as PHYS 685

prereq: a course in ordinary differential equations

MATH 695 Numerical Methods II

Topics in numerical methods selected from: solution of linear equations, interpolating functions, root finding methods, nonlinear equations, Fourier series and fast Fourier transform, partial differential equations.

Note: Cross-listed as PHYS 695

prereq: MATH 685 or equivalent

MATH 721 Modern Algebra I

Semi-groups, groups with operators, rings, modules, field extensions, vector spaces.

prereq: an undergraduate course in linear algebra and an undergraduate course in abstract algebra

MATH 722 Modern Algebra II

Continuation of **MATH 721**

prereq: MATH 721

MATH 746 Theory of Functions of a Real Variable I

Real numbers, Lebesgue measure, metric and L_p spaces, general measure and integration theory.

prereq: 1 year of advanced calculus

MATH 747 Theory of Functions of a Real Variable II

prereq: MATH 746

MATH 772 Seminar

Introduction to methods and literature of mathematical research at master's level.

prereq: permission of the department

MATH 773, 774 Independent Study

prereq: permission of the department
45 hrs, 1 cr each

MATH 775, 776 Independent Study

prereq: permission of the department
45 hrs, 2 cr each

MATH 777, 778 Independent Study

prereq: permission of the department

APPLIED MATHEMATICS

STAT 614 Data Analysis Using Statistical Software

A second course in statistics using statistical software to analyze real data and teach new methodology. Methods covered include exploratory data analysis, analysis of variance, simple and multiple regression, nonparametric statistics and model building.

prereq: STAT 213 or both MATH 125 and STAT 113 with C or better in each course
familiarity with a Windows computing environment encouraged

STAT 711 Statistical Decision Theory I

Bayes, admissible, and minimax decision rules. Geometric interpretations. Sufficiency. Theory of optimal point estimation.

prereq: a course in linear algebra; coreq: advanced calculus or permission of the department

STAT 712 Statistical Decision Theory II

Continuation of **STAT 711**. Hypothesis testing and confidence sets. Optimal tests, invariance. Applications to ANOVA, regression, design, non-parametric inference.

prereq: STAT 711

STAT 713 General Linear Models

A course in Analysis of Variance (ANOVA) and Regression Analysis which emphasizes building complex models from large, often "messy," data sets, using SAS statistical software. Lab sessions will alternate with lectures.

prereq: Satisfactory performance in an introductory level course in applied statistics, such as STAT 213 or 113. Familiarity with linear algebra is encouraged.
Familiarity with a Windows computing environment encouraged.

STAT 714 Topics in Statistical Inference

Topics vary but may be selected from multivariate analysis, regression, experimental design, time series, biostatistics.

STAT 715 Time Series Analysis

Introduction to univariate Box-Jenkins (difference equation) time-series modeling. Topics include ARIMA models; stationarity; forecasting; diagnostics; and seasonal modeling. Extensive use of process control and economic time series. Transfer function models.

prereq: C or better in STAT 614, or an equivalent introductory statistics course.
familiarity with a Windows computing environment encouraged

STAT 716 Data Analysis

Probability-free alternatives to classical statistics, concentrating on graphical and robust methods. Topics selected from: data summaries; transformations; the jackknife and resampling schemes; robust estimation; and robust regression methods.

prereq: C or better in STAT 614, or an equivalent introductory statistics course.

STAT 717 Multivariate Analysis

An introduction to multivariate methods. Topics selected from: factor analysis; discriminant analysis; clustering; multidimensional scaling; MANOVA; canonical correlation; and projection-pursuit.

prereq: C or better in STAT 614, or an equivalent introductory statistics course.
familiarity with a Windows computing environment encouraged
spring and/or fall, please check with the dept

STAT 718 Analysis of Variance

Intermediate topics in analysis of variance (ANOVA), with an emphasis on exploratory aspects. Topics include: one-, two- and many-way layouts; decomposition and partitioning of variance; fixed-, random-, and mixed-effects models; repeated measures; contrasts; multiple comparisons; and robust analogs.

prereq: C or better in STAT 614, or an equivalent introductory statistics course.
familiarity with a Windows computing environment encouraged

STAT 720 Advanced Probability Theory I

Non-measure theoretic probability. Combinatorics, random variables, distributions. Moment generation functions. Limit laws.

prereq: A course in multivariate calculus (MATH 250 or equivalent) or permission of department

STAT 721 Advanced Probability Theory II

Continuation of **STAT 720**. Recurrent events, Markov chains, diffusion. Introduction to stochastic processes.

prereq: STAT 720 or permission of the department

STAT 722 Theory of Games

Utility, zero-sum two-person games, minimax theorem or rectangular games. Relation to linear programming; applications to problems in economics and other fields.

prereq: A course in linear algebra and a course in probability.

STAT 724 Topics in Applied Mathematics I

Topics vary but may be selected from multivariate analysis, regression, experimental design, time series, biostatistics.

prereq: permission of the department

STAT 725 Topics in Applied Mathematics II

Topics vary but may be selected from multivariate analysis, regression, experimental design, time series, biostatistics.

prereq: permission of the department

STAT 726 The Theory and Methods of Sampling

Introduction to the techniques of modern sampling, including both the methods of sampling and the theory supporting these methods.

Efficient sampling, analysis and consideration of biases, precision and accuracy.

prereq: STAT 720 or equivalent, or permission of the department

STAT 730 Mathematical Statistics

Estimation and hypothesis testing, including t , Chi-squared, F tests. Applications of linear regression and ANOVA.

prereq: permission of the department

STAT 751 Advanced Biometrics

A second course in statistics covering quantitative methods applicable in the life sciences. Topics include experimental design, life table analysis, ethical issues, survival analysis, logistic regression, and Cox regression.

STAT 791, 792, 793 Independent Study

Independent study in which a student selects a topic of interest to him or herself. The study is carried out under the direction of a faculty member.

1 cr, 2 cr, or 3 cr

Courses offered only if student demand is sufficient:

MATH 625 Introduction to Linear Algebra

MATH 628 Number Systems

MATH 670 Foundations of Mathematics

MATH 725 Linear Algebra

MATH 741 Functional Analysis

MATH 742 Theory of Functions of a Complex Variable

MATH 751 General Topology

STAT 632 Nonparametric Statistics

STAT 633 Analysis of Categorical Data

STAT 634 Regression Analysis

STAT 635 Continuous Multivariate Analysis

STAT 636 Sample Surveys

STAT 637 Experimental Design and Analysis of Variance

STAT 638 Special Topics in Applied Statistics

STAT 681 Numerical Methods

STAT 731 Operations Research I

STAT 732 Operations Research II

STAT 750 Theory of Linear Models

STAT 781 Advanced Numerical Methods

STAT 790 Case Seminar