Mathematics (MAT)

Chair: David Ebin, Mathematics Building Room 5-116, (631) 632-8290
Graduate Program Director: Claude LeBrun, Mathematics Building Room 3-108, (631) 632-8254
Associate Graduate Program Director for Secondary Teacher Option Program: Bernard Maskit, Mathematics Building Room 5-112, (631) 632-8257
Graduate Secretary: Donna McWilliams, Mathematics Building Room P-143, (631) 632-8282

Degrees awarded: M.A. in Mathematics 7-12; M.A. in Mathematics; Ph.D. in Mathematics

The Department of Mathematics, in the College of Arts and Sciences, offers degree programs leading to the M.A. in Mathematics (Secondary Teacher Option), the M.A. in Mathematics, and the Ph.D. in Mathematics. Several surveys, including the latest in *U.S. News & World Report*'s "America's Best Graduate Schools," rank the Department's graduate program in the top 25 in the nation.

Master of Arts in Teaching Mathematics 7 to 12

This is a 42-credit master's program administered by the School of Professional Development (SPD). It is designed for students who already have a bachelor's degree in mathematics or the equivalent and who wish to teach mathematics in grades 7 to 12. Individuals interested in this program should refer to SPD's online *Bulletin*: *www.stonybrook.edu/spd/graduate/matmath*

The M.A. Program:
Secondary Teacher Option

The Secondary Teacher Option is a 30-credit, two-year, part-time program designed for secondary school mathematics teachers who are seeking permanent certification. The nine required courses in the program are given in the evenings and in the summer on a rotating basis; each required course is offered at least once every two and a half years.

Admission

In addition to the Graduate School requirements, the minimum requirements for admission to this program are:

A. A bachelor's degree;

B. Two years of college-level mathematics, including one year of single variable calculus, one semester of linear algebra, and one additional semester of mathematics beyond single variable calculus;

C. Provisional New York State Certification for Teaching Mathematics, Grades 7 to 12;

D. A grade point average of at least 3.0 in all calculus and post-calculus mathematics courses;

E. Evidence that the student is likely to succeed: this usually consists of three letters of recommendation from former teachers or supervisors;

F. Acceptance by both the Department of Mathematics and the Graduate School.

The M.A. and Ph.D. Programs:
Professional Option

The Professional Option is designed for students who plan careers as professional mathematicians in research and/or teaching at universities and colleges (including two-year colleges), in industry, or in government. With rare exceptions, all students in this option are full-time students, and at least one year of full-time study is required.

Admission

In addition to the Graduate School requirements, the minimum requirements for admission to this program are:

A. A bachelor's degree with a major in mathematics, or the equivalent;

B. Evidence that the student is likely to succeed: this must include three letters of recommendation from mathematicians, usually from present or former teachers; the breadth and depth of mathematic courses taken, the grades obtained in these courses, as well as test scores on the Graduate Record Examination (GRE) General Test and a personal background essay are also considered;

C. Foreign students: Evidence that the student can understand and speak English sufficiently well; a TOEFL score paper based of 550, computer-based of 21, or iBT-based of 90 is considered satisfactory;

D. Acceptance by both the Department of Mathematics and the Graduate School.

Faculty

Distinguished Professors

Glimm, James, Ph.D., 1959, Columbia University: Applied mathematics; numerical analysis; mathematical physics.

Lawson, H. Blaine, Jr., Ph.D., 1968, Stanford University: Differential geometry; topology; algebraic geometry.

McDuff, Dusa, Ph.D., 1971, University of Cambridge, England: Geometry; symplectic topology.

Milnor, John W.,[2] *Director of the Institute for Mathematical Sciences,* Ph.D., 1954, Princeton University: Dynamical systems; topology; geometry.

Sullivan, Dennis,[2] Ph.D., 1965, Princeton University: Dynamical systems; topology; geometry; partial differential equations; quantum topology.

Distinguished Service Professor

Kra, Irwin, *Emeritus*, Ph.D., 1966, Columbia University: Complex analysis; Kleinian groups.

Professors

Anderson, Michael, Ph.D., 1981, University of California, Berkeley: Differential geometry; geometric analysis; mathematical physics.

Barcus, William, *Emeritus,* D.Phil., 1955, University of Oxford, England: Algebraic topology.

Bishop, Christopher, Ph.D., 1987, University of Chicago: Complex analysis.

Ebin, David, *Chair,* Ph.D., 1967, Massachusetts Institute of Technology: Global analysis; mathematics of continuum mechanics; partial differential equations.

Fox, William, *Emeritus,* Ph.D., 1955, University of Michigan: Complex analysis.

Geller, Daryl, Ph.D., 1977, Princeton University: Partial differential equations; harmonic analysis.

Gromoll, Detlef, Ph.D., 1964, University of Bonn, Germany: Differential geometry.

Hill, C. Denson, Ph.D., 1966, New York University: Partial differential equations; several complex variables.

Jones, Lowell, Ph.D., 1970, Yale University: Topology; geometry.

Knapp, Anthony, *Emeritus,* Ph.D., 1965, Princeton University: Lie groups; representation theory.

Kumpel, Paul,[1] *Emeritus*, Ph.D., 1964, Brown University: Algebraic topology.

LeBrun, Claude, *Graduate Program Director*, D.Phil., 1980, University of Oxford, England: Differential geometry; complex analysis; mathematical physics; algebraic geometry.

Lister, William, *Emeritus,* Ph.D., 1951, Yale University: Algebra.

Lyubich, Mikhail,[2] *Deputy Director of the Institute for Mathematical Sciences,* Ph.D., 1983, Tashkent State University, Russia: Dynamical systems.

Maskit, Bernard, Ph.D., 1964, New York University: Complex analysis; Riemann surfaces; Kleinian groups and their deformation spaces.

Michelsohn, Marie-Louise, Ph.D., 1974, University of Chicago: Differential geometry.

Phillips, Anthony V., Ph.D., 1966, Princeton University: Differential topology and applications to mathematical physics.

Pincus, Joel, *Emeritus*, Ph.D., 1959, New York University: Operator theory and integral equations.

Szusz, Peter, *Emeritus,* Ph.D., 1951, University of Budapest, Hungary: Analytic number theory.

Takhtajan, Leon, Ph.D., 1975, Leningrad Branch of the Steklov Mathematical Institute, Russia: Mathematical physics.

Associate Professors

de Cataldo, Mark, Ph.D., 1995, University of Notre Dame: Higher dimensional geometry.

Kirillov Jr., Alexander, Ph.D., 1995, Yale University: Representation theory; low dimensional topology; mathematical physics.

Popescu, Sorin, Ph.D., 1993, University of Saarland, Germany: Algebraic geometry and computational algebraic geometry.

Martens, Marco, Ph.D., 1990, Delft University, The Netherlands: Dynamics.

Movshev, Michael, Ph.D., 1997, University of Pennsylvania: Algebra.

Sutherland, Scott,[2] *Director of Computing,* Ph.D., 1989, Boston University: Dynamical systems; root-finding algorithms; computing.

Assistant Professor

Berger, Lisa, Ph.D., 2007, University of Arizona: Number theory, mathematics education of teachers.

Kennedy, Nadia, Ed.D., 2005, Montclair State University: Mathematics education.

Khuri, Marcus, Ph.D., 2003, University of Pennsylvania: Differential geometry, partial differential equations, and general relativity.

Plamenevskaya, Olga, Ph.D., 2004, Harvard University: Contact and symplectic geometry, low-dimensional topology.

Starr, Jason, Ph.D., 2000, Harvard University: Algebraic geometry.

Varolin, Dror, Ph.D., 1997, University of Wisconsin-Madison: Complex analysis and geometry.

Zinger, Aleksey, Ph.D., 2002, MIT: Symplectic topology; enumerative algebraic geometry.

James H. Simons Instructors

He, Xuhua, Ph.D., 2005, MIT: Representation theory, algebraic geometry.

Kamenova, Ljudmila, Ph.D., 2006, MIT: Complex geometry.

Redden, Corbett, Ph.D., 2006, Notre Dame University: Riemannian geometry, algebraic topology.

Simon, Scott, Ph.D., 2006, Purdue University: Infinite-dimensional complex analysis, several complex variables.

Wang, Qian, Ph.D., 2006, Princeton University: Partial differential equations, geometric analysis, harmonic analysis.

Lecturers and Visitors

Andersen, Robert, M.S., 1974, Adelphi University, N.Y.: Mathematics education.

Bernhard, William, M.A., 2000, Stony Brook University: Mathematics education.

Chas, Moira, Ph.D., 1998, Universitat Autonoma de Barcelona, Spain: Dynamical systems; geometric topology.

Wiegand, Judy, M.S., 1969, Polytechnic Institute of New York, Brooklyn: Hamilton graph theory; teacher education.

RTG Postdoctoral Fellows

Harrelson, Eric, Ph.D., 2006, University of Minnesota: Algebraic topology, string field theory.

Linch III, William, Ph.D., 2005, University of Maryland at College Park: Theoretical and mathematical physics.

Weber, Brian, Ph.D., 2007, University of Wisconsin: Differential geometry.

Institute for Mathematical Sciences

Lyubich, Mikhail,[2] *Deputy Director of the Institute for Mathematical Sciences*, Ph.D., 1983, Tashkent State University, Russia: Dynamical systems.

Milnor, John W.,[2] *Director of the Institute for Mathematical Sciences*, Ph.D., 1954, Princeton University: Dynamical systems; topology, geometry.

1) Recipient of the State University Chancellor's Award for Excellence in Teaching, 1990

2) Member, Institute for Mathematical Sciences

Degree Requirements
Requirements for the M.A. Degree

In addition to the requirements of the Graduate School, the following are required:

A. Completion of 30 credits in graduate courses approved by the Department with a 3.0 overall grade point average;

B. Passing the comprehensive examination;

C. A nine-credit minor.

For students in the Secondary Teacher Option, the 30-credit requirement is ordinarily satisfied by the following courses: MAT 511 Fundamental Concepts of Mathematics, MAT 512 Algebra for Teachers, MAT 513-514 Analysis for Teachers I-II, MAT 515 Geometry for Teachers, MAT 516 Probability and Statistics for Teachers, MAT 517 Calculators and Computers for Teachers, MAT 518 Seminar in the Uses of Mathematics, MAT 519 Seminar in Mathematics Teaching, and a three-credit elective with a significant mathematical or pedagogical component. The comprehensive examination consists of the final examinations in MAT 512, 513, 514, and 515. The minor requirement is met by the three courses MAT 516, MAT 517, and MAT 518.

For students in the Professional Option, the courses that satisfy the 30-credit requirement are MAT 530-531 Topology/ Geometry I-II, MAT 534-535 Algebra I-II, MAT 542 Complex Analysis I, MAT 544 Real Analysis I, MAT 550 Real Analysis II, and MAT 598 Teaching Practicum. Unless specifically exempted by the Director of Graduate Studies, all first-year graduate students are required to take the core courses, MAT 530, 531, 534, 535, 542, 544, and 550 during their first year; this requirement is automatically waived for students who have passed the comprehensive examination (see the *Guide to Graduate Study* for exemption guidelines).

In addition, students preparing for the doctoral program ordinarily take MAT 590 Problem Seminar. The comprehensive examination consists of the final examinations in MAT 530, 531, 534, 535, 542, 544, and 550, or the equivalent. The minor program consists of three courses in an allied area such as applied mathematics, computer science, statistics, or theoretical physics.

Requirements for the Ph.D. Degree

In addition to the requirements of the Graduate School, the following are required:

A. Passing the doctoral comprehensive examination;

B. Passing the doctoral preliminary examination;

C. Demonstrating proficiency in reading mathematics in two relevant

foreign languages, usually French, German, or Russian; non-English-speaking international students can demonstrate their proficiency in one of these languages, in addition to their native language;

D. Advancement to candidacy;

E. Writing an acceptable dissertation;

F. Two consecutive semesters of full-time study.

Doctoral Comprehensive Examination

This examination, which is offered twice a year (just before the start of each semester), is designed to test mastery of the fundamentals of mathematics. This exam is based on the syllabi of the core courses: MAT 530, 531, 534, 535, 542, 544, 550. Students who transfer from graduate programs at other universities may, in some cases, be granted exemption from this requirement.

Doctoral Preliminary Examination

This examination is oral. Each student must take this examination no later than one year after passing the comprehensive examination or receiving an exemption therefrom. The chair and one additional member of the examining committee are chosen by the student; one additional member is chosen by the program.

Professional Academic Training Program

All full-time graduate students are required to participate in this program, consisting of supervised teaching/tutoring at the lower undergraduate levels.

Courses

Mathematics Education Courses

Visit our Web site for the most current descriptions: *www.math.sunysb.edu*

MAE 501 Foundations of Secondary Mathematics Curriculum

A re-examination of the current middle school and high school mathematics curriculum. A review of the techniques and discussion of the ideas from a more advanced point of view, including topics in algebra, geometry, elementary functions, and probability and statistics. Competence in basic secondary school mathematical ideas and techniques is tested.
Fall, 3 credits, ABCF grading

MAE 510 Introduction to Methods of Teaching and Learning Standards

Introduction to the basic methods of teaching middle school and high school mathematics, including study of lesson designs based on National Council of Teachers of Mathematics (NCTM) and New York State standards, and the study of pedagogical techniques including cooperative learning and the uses of technology. Students also engage in guided observation of middle school and high school mathematics classes.
Pre- or Co-requisite: MAE 501
Fall, 3 credits, ABCF grading

MAE 520 Advanced Methods of Teaching Secondary School Mathematics

The philosophy and goals of mathematics education, with an emphasis on implementation: curriculum development; teaching techniques and styles, and learning theories and styles; lesson planning and assessment. Students will plan an entire unit, the work sample, including lesson plans and assessments, for inclusion in the professional portfolio.
Prerequisites: MAE 501 and 510
Spring, 3 credits, ABCF grading

MAE 530 Directed Readings and Research Paper in Mathematics Education

Tutorial studies concerning current issues in Mathematics Education, including recent research and its relation to teaching practice. Students write a 10-page paper for inclusion in the professional portfolio.
Prerequisites: MAE 501 and 510
Fall, spring, 1 credit, ABCF grading

MAE 540 Clinical Experience

Supervised classroom experience in both middle school and high school settings, including experience in a high-needs district, individual tutoring, working with small groups, and working as an inclusion aide. Seminar discussions focus on classroom observations and experiences.
Prerequisites: MAE 501 and 510
Pre- or Co-requisite: MAE 520
Spring, 2 credits, ABCF grading

MAE 551 Supervised Student Teaching in Middle School

Student teaching under the supervision of an experienced teacher in middle school and high school settings. These courses must be taken simultaneously.
Prerequisites: MAE 520, 530, and 540; satisfaction of all other program requirements; permission of the Director of Mathematics Education
Co-requisite: MAE 552 and 554
Fall, spring, 3 credits, S/U grading

MAE 552 Supervised Student Teaching in High School

Student teaching under the supervision of an experienced teacher in middle school and high school settings. These courses must be taken simultaneously.
Prerequisites: MAE 520, 530, and 540; satisfaction of all other program requirements; permission of the Director of Mathematics Education
Co-requisite: MAE 552 and 554
Fall, spring, 3 credits, S/U grading

MAE 554 Student Teaching Seminar

The student teaching experience (MAE 551/552) serves as a focus for weekly discussions of teaching and learning styles and techniques, and classroom management issues. Includes New York State mandated seminars on child abuse, substance abuse, and school violence.
Prerequisite: Permission of the Director of Mathematics Education
Corequisites: MAE 551 and 552
Fall, spring, 3 credits, ABCF grading

Core Courses for Teacher Option

Visit our Web site for the most current descriptions: *www.math.sunysb.edu*

MAT 511 Fundamental Concepts of Mathematics

Brief history of mathematics; sets, functions and logic; constructions of number systems; mathematical induction. The main focus of the course will be on the construction and writing of mathematical proofs.
Fall, spring, or summer, 3 credits, ABCF grading

MAT 512 Algebra for Teachers

Linear algebra, the algebra of polynomials, algebraic properties of the complex numbers, number fields, solutions of equations.
Prerequisite: MAT 511
Fall, spring, or summer, 3 credits, ABCF grading

MAT 513 Analysis for Teachers I

Topics in differential calculus, its foundations, and its applications. This course is designed for teachers and prospective teachers of advanced placement calculus.
Prerequisite: MAT 511
Fall, spring, or summer, 3 credits, ABCF grading

MAT 514 Analysis for Teachers II

Topics in calculus, its foundations, and its applications. Emphasis is on integration and on numerical techniques. This course is designed for teachers and prospective teachers of advanced placement calculus. Analysis for Teachers I is not a prerequisite for this course.
Prerequisite: MAT 511
Fall, spring, or summer, 3 credits, ABCF grading

MAT 515 Geometry for Teachers

A re-examination of elementary geometry using concepts from analysis and algebra.
Prerequisite: MAT 511
Fall, spring, or summer, 3 credits, ABCF grading

MAT 516 Probability and Statistics for Teachers

A priori and empirical probabilities; conditional probability; mean and standard deviation; random variables; financial distributions; continuous distributions; sampling; estimation; decision making.
Fall, spring, or summer, 3 credits, ABCF grading

MAT 517 Calculators and Computers for Teachers

Calculators and Computers for teachers. Graphing calculators, programming, comput-

ing and curve sketching; Geometers Sketchpad or other computer-based classroom tools; educational use of the Web.
Fall, spring, or summer, 3 credits, ABCF grading

MAT 518 Seminar on the Uses of Mathematics
This seminar explores the ways in which secondary school and elementary college mathematics are used in such diverse areas as psychology, sociology, political science, economics, business, engineering, physics, chemistry, biology, and medicine. Primarily for secondary school teachers of mathematics.
Fall, spring, or summer, 3 credits, ABCF grading

MAT 519 Seminar in Mathematics Teaching
Study of recent curricular and pedagogical developments in secondary school mathematics.
Fall, spring, or summer, 3 credits, S/U grading

Introductory Courses for Professional Option
Visit our Web site for the most current descriptions: *www.math.sunysb.edu*

MAT 530 Topology, Geometry I
Basic point set topology; connectedness, compactness, continuity, etc. Metric spaces, function spaces, and topological manifolds. Introduction to algebraic topology; fundamental group and covering space; homology; applications.
Fall, 3 credits, ABCF grading

MAT 531 Topology, Geometry II
Foundations of differentiable manifolds: differentiable maps, vector fields and flows, and differential forms and integration on manifolds. Stokes' theorem. Froebenius theorem. Lie derivatives. Immersions and submersions. DeRham chomology, cochain complexes, degree of a map, Mayer-Vietoris Theorem.
Spring, 3 credits, ABCF grading

MAT 534 Algebra I
Groups: normal subgroups, quotient groups, Lagrange's theorem, class formula, finite p-groups and solvable groups, Sylow's theorems, finitely generated abelian groups. Rings and modules: subrings, fields, prime and maximal ideals, quotient rings, ID's, PID's, UFD's, polynomial rings, field of fractions, the Wedderburn theorem, Hilbert basis theorem, finitely generated modules over a PID. Vector spaces: basis, linear maps and matrices, dual spaces, determinants, eigen values and vectors, inner products, spectral theorem for normal operators.
Fall, 3 credits, ABCF grading

MAT 535 Algebra II
Vector spaces: Cayley-Hamilton Theorem, Jordon normal form, binlinear forms, signature, tensor products, symmetric and exterior algebras. Homological algebra: categories and functors, universal and free objects, exact sequences, extensions. Representation theory for finite groups: irreducible representations and Shur's Lemma, characters, orthogonality. Galois theory: splitting fields, finite fields, extension fields of various types, Galois poly-

nomial and group, fundamental theorem of Galois theory, symmetric functions.
Spring, 3 credits, ABCF grading

MAT 536 Algebra III
Selections from the following topics: introductory algebraic number theory, introductory algebraic geometry, algebraic groups, cohomology of groups, homological algebra, advanced field theory and Galois theory, central simple algebras, representations of finite and compact groups.
Prerequisite: MAT 535
Fall, 3 credits, ABCF grading

MAT 539 Algebraic Topology
Homology and cohomology groups, homotopy groups and the Hurewicz theorem, the universal coefficient theorem, cup and cap products, Poincare duality, and introduction to spectral sequences.
Spring, 3 credits, ABCF grading

MAT 540 Topology in Geometry and Algebra I
Cell complexes, algebraic and geometric definitions of homology, fundamental and higher homotopy groups, Hurewicz theorem, Lefschetz theorem and related topics.
Prerequisites: MAT 530, MAT 531
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 541 Topology in Geometry and Algebra II
Cohomology, relations with obstruction and deformation theory, Poincare, Lefschetz, and Alexander dualities, intersection theory, relations to differential forms, monodromy, and related topics.
Prerequisites: MAT 530, MAT 531
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 542 Complex Analysis I
Elementary functions, holomorphic functions. Cauchy theory, power series, classification of isolated singularities, calculus of residues, open mapping theorem, Riemann mapping theorem.
Spring, 3 credits, ABCF grading

MAT 543 Complex Analysis II
Monodromy theorem and analytic continuation. Elliptic functions. Dirichlet problem and Green's function. Conformal mappings. Introduction to Riemann surfaces and/or several complex variables.
Fall, alternate years, 3 credits, ABCF grading

MAT 544 Real Analysis I
Ordinary differential equations; Banach and Hilbert spaces; inverse and implicit function theorems; Lebesque measure; general measures and integrals; measurable functions; convergence theorems for integrals.
Fall, 3 credits, ABCF grading

MAT 545 Complex Geometry
Foundational material and techniques in complex algebraic and differential geometry: Review of basic results in several complex variables/analytic geometry, sheaves and cohomology of sheaves, complex vector bundles, Chern classes, positivity, Kaehler manifolds, projective manifolds, Hodge decom-

position for Kaehler manifolds, Kodaira vanishing theorem, Hard Lefschetz Theorem, divisors and line bundles, Bertini's theorem, Lefschetz theorem on (1,1) classes, blowing up, Kodaira's embedding theorem.
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 546 Differential Equations
Distributions and the Fourier transform; compact operators, Fredholm theory; pseudo-differential operators; Sobolev spaces; regularity theory for elliptic operators; Hodge theorem.
Prerequisite: MAT 544
Corequisite: MAT 550
Spring, 3 credits, ABCF grading

MAT 550 Real Analysis II
Representations and decomposition theorems in measure theory; Fubini's theorem; L^p spaces; Fourier series; Laplace, heat, and wave equations; open mapping and uniform boundedness theorems for Banach spaces; differentiation of the integral; change of variable of integration.
Prerequisite: MAT 544
Spring, 3 credits, ABCF grading

MAT 551 Real Analysis III
Selections from the following topics. Partial differential equations in higher dimensions; Sobolev spaces, calculus of variations, characteristics, Cauchy problem, energy estimates, maximum principles, Harmonic analysis; singular integrals, Hausdorff measure, harmonic measure, Hardy spaces, Functional analysis; spectral theory, distributions, Banach algebras.
Prerequisite: MAT 544, 550
Fall, 3 credits, ABCF grading

MAT 552 Introduction to Lie Groups and Lie Algebras
Lie algebras, foundations of Lie groups and Lie algebras, classical groups and homogeneous spaces. Abstract Lie algebras. Basic representation theory of compact Lie groups.
Prerequisite: MAT 531, MAT 534
Fall, 3 credits, ABCF grading

MAT 555 Introduction to Dynamical Systems
Fundamental themes of dynamical systems and applications to other areas. Topics may include the following: Poincare recurrence and Birkhoff Ergodic Theorem, Smale horseshoe and hyperbolicity, geodesic flow on constant curvature surfaces, one-dimensional dynamics, Julia sets and Mandelbrot set, renormalization, rigidity and universality phoneomena, Hamiltonian dynamics and integrability, Kolmogorov-Arnold-Moser Theory (overview), Homoclinic bifurcations and New-house phenomenon.
Prerequisite: MAT 530, MAT 544
Spring, 3 credits, ABCF grading

MAT 560 Mathematical Physics I
Aimed at students affiliated with the RTG program. Topics include classical field theory (Lagrangian and Hamiltonian), electromagnetism, special relativity, statistical mechanics and thermodynamics, quantum mechanics and quantum field theory.
3 credits, ABCF grading

MAT 561 Mathematical Physics II

Aimed at students affiliated with the RTG program. Topics include classical field theory (Lagrangian and Hamiltonian), electromagnetism, special relativity, statistical mechanics and thermodynamics, quantum mechanics and quantum field theory.
Spring, 3 credits, ABCF grading

MAT 566 Differential Topology

Vector bundles, transversality, and characteristic classes. Further topics such as imbeddings and immersions, intersection theory, surgery, and foliations.
Prerequisite: MAT 531
Fall, 3 credits, ABCF grading

MAT 568 Differential Geometry

Connections, curvature, geodesics, parallelism, and completeness. Riemannian manifolds, geometry of sub-manifolds; method of integral formulas; applications to global extrinsic theorems. Riemannian curvature. Gauss-Bonnet theorem, Hopf-Rinow theorem.
Prerequisite: MAT 531
Fall, 3 credits, ABCF grading

MAT 569 Differential Geometry

First and second variation formulas, conjugate points and Jacobi fields, comparison theory. Curvature and fundamental group: spaces of positive and of negative curvature, space forms, Lie groups, homogeneous spaces, and symmetric spaces. Different topics may be covered depending on the choice of the instructor.
Prerequisite: MAT 531, MAT 568
Spring, 3 credits, ABCF grading

MAT 570 Concepts and Methods of Quantum Mechanics

Mathematical methods of classical mechanics: Lagrangian and Hamiltonian formulations, conservation laws. Mathematical foundation of quantum mechanics: Heisenberg and Schrodinger representations, Stone-von Neumann theorem. Examples of fundamental quantum mechanical problems, representation theory and spin. Feynman path integral formalism and related Wiener theory of integration, perturbation theory, semi-classical approximation, fermion systems. Mathematical applications.
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 588 First-Year Seminar I

Workshop on basic graduate-level mathematics skills and knowledge. Skills include reading and writing proofs, solving problems, reading mathematics. Topics cover fundamental ideas and theories such as constructions of number systems, interchange of limits, the Euclidean algorithm, and the axiom of choice.
Fall, 3 credits, S/U grading

MAT 589 First-Year Seminar II

Same concept as MAT 588, but covers different materials.
Spring, 3 credits, S/U grading

MAT 590 Problem Seminar

Analyze problems and explore supplementary topics related to the core courses in the Professional M.A. Option. Focus on preparation for the doctoral comprehensive examination.

Fall and spring, 3 credits, S/U grading
May be repeated for credit

MAT 598 Teaching Practicum

Seminar and workshop for new teaching assistants.
Fall, 3 credits, S/U grading

MAT 599 M.A. Research

1-12 credits, S/U grading
May be repeated for credit

Intermediate Courses

These courses are designed for second- and third-year graduate students who are preparing for the doctoral preliminary examination or are starting work toward a dissertation. Topics covered are chosen to reflect interest of instructors and students. All may be taken for repeated credit. Visit *www.math.suny sb.edu* for current descriptions.

MAT 602 Topics in Algebra

Typical topics are drawn from group theory, ring theory, representation theory of groups and algebras, fields and commutative algebra, homological algebra.
Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 603 Topics in Algebra

Typical topics are drawn from group theory, ring theory, representation theory of groups and algebras, fields and commutative algebra, homological algebra.
Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 608 Topics in Number Theory

Typical topics are drawn from analytic number theory, algebraic number theory, diophantine equations, and transcendental number theory, with indications of methods from algebra, geometry, analysis, and logic.
Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 609 Topics in Number Theory

Typical topics are drawn from analytic number theory, algebraic number theory, diophantine equations, and transcendental number theory, with indications of methods from algebra, geometry, analysis, and logic.
Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 614 Topics in Algebraic Geometry

Topics are drawn from varieties and schemes, algebraic curves, and their arithmetics.
Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 615 Topics in Algebraic Geometry

Typical topics are drawn from varieties and schemes, algebraic curves, and their arithmetics.
Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 620 Topics in Algebraic Topology

Topics of current interest such as foliations, surgery, singularities, group actions on manifolds, and homotopy theory.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 621 Topics in Algebraic Topology

Topics of current interest such as foliations, surgery, singularities, group actions on manifolds, and homotopy theory.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 626 Topics in Complex Analysis

Topics selected from Riemann surfaces, quasiconformal mappings, several complex variables, Fuchsian groups, Kleinian groups, moduli of Riemann surfaces and Kleinian groups, analytic spaces, singularities.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 627 Topics in Complex Analysis

Topics selected from Riemann surfaces, quasiconformal mappings, several complex variables, Fuchsian groups, Kleinian groups, moduli of Riemann surfaces and Kleinian groups, analytic spaces, singularities.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 632 Topics in Differential Equations

Typical topics are hyperbolic or elliptic systems, parabolic equations, spectral theory, finite difference equations, Cauchy-Riemann equations and complex vector fields, equations with constant coefficients, solvability of linear equations, Fourier integral operators, nonlinear equations.
Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 633 Topics in Differential Equations

Typical topics are hyperbolic or elliptic systems, parabolic equations, spectral theory, finite difference equations, Cauchy-Riemann equations and complex vector fields, equations with constant coefficients, solvability of linear equations, Fourier integral operations, nonlinear equations.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 638 Topics in Real Analysis

Topics selected from functional analysis, harmonic analysis, Banach algebras, operator theory.
Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 639 Topics in Real Analysis

Topics selected from functional analysis, harmonic analysis, Banach algebras, operator theory.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 641 Topics in Lie Groups Theory

Typical topics are universal enveloping algebras; free, solvable and nilpotent Lie algebras; Lie theory and formal groups; root systems, Dynkin diagrams, classification and representations of complex semisimple Lie algebras; method of orbits; representations of non-compact Lie groups; loop groups.
Prerequisite: MAT 552
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 644 Topics in Differential Geometry

Typical topics will be drawn from areas such as comparison theorems, pinching theorems, Morse theory, characteristic classes, minimal varieties, Hodge theory, spectrum of the Laplacian, and geometry of general relativity.
Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 645 Topics in Differential Geometry

Typical topics will be drawn from areas such as comparison theorems, pinching theorems, Morse theory, characteristic classes, minimal varieties, Hodge theory, spectrum of the Laplacian, and geometry of general relativity.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 648 Topics in Mathematical Physics

Typical topics are mathematical methods of classical and quantum mechanics; methods of functional integration and its applications; infinite-dimensional Lie algebras, quantum groups and representations; conformal field theories; super-symmetry; topological quantum field theories; gauge theories and geometry in four-dimensions; supergravity and mirror symmetry; strings.
Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 649 Topics in Mathematical Physics

Typical topics are mathematical methods of classical and quantum mechanics; methods of functional integration and its applications; infinite-dimensional Lie algebras, quantum groups and representations; conformal field theories; super-symmetry; topological quantum field theories; gauge theories and geometry in four-dimensions; supergravity and mirror symmetry; strings.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 655 Topics in Dynamical Systems

Typical topics are drawn from holomorphic and low-dimensional dynamics, hyperbolic dynamics, theory of Hamiltonian systems, ergodic theory, and bifurcation theory.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 656 Topics in Dynamical Systems

Typical topics are drawn from holomorphic and low-dimensional dynamics, hyperbolic dynamics, theory of Hamiltonian systems, ergodic theory, and bifurcation theory.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

Advanced Courses

These courses are designed for students doing advanced work, especially in connection with doctoral dissertations. The only prerequisite is permission of the instructor. The topics are selected from the areas listed under the corresponding intermediate course and will generally be on a more advanced level. A course normally begins in the fall and may continue in the spring. Course offerings will depend on student demand and availability of faculty to supervise advanced work in the area. Courses may be taken for repeated credit; each carries three credits. Visit *www.math.sunysb.edu* for current descriptions.

MAT 662 Advanced Topics in Algebra

Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 663 Advanced Topics in Algebra

Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 666 Advanced Topics in Algebraic Topology

Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 667 Advanced Topics in Algebraic Topology

Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 670 Advanced Topics in Complex Analysis

Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 671 Advanced Topics in Complex Analysis

Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 674 Advanced Topics in Differential Equations

Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 675 Advanced Topics in Differential Equations

Prerequisite: Permission of instructor

Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 678 Advanced Topics in Real Analysis

Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 679 Advanced Topics in Real Analysis

Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 682 Advanced Topics in Differential Geometry

Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 683 Advanced Topics in Differential Geometry

Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 685 Advanced Topics in Dynamics

An advanced topic selected from holomorphic and low-dimensional dynamics, hyperbolic dynamics, KAM theory, smooth ergodic theory, geodesic flows, bifurcation theory.
Prerequisite: Permission of instructor
Fall, 3 credits, ABCF grading
May be repeated for credit

MAT 686 Advanced Topics in Dynamics

An advanced topic selected from holomorphic and low-dimensional dynamics, hyperbolic dynamics, KAM theory, smooth ergodic theory, geodesic flows, bifurcation theory.
Prerequisite: Permission of instructor
Spring, 3 credits, ABCF grading
May be repeated for credit

MAT 690 RTG Seminar in Mathematics and Physics I

Intensive learning seminar aimed at first- and second-year graduate students. The main purpose is to introduce mathematics students to the methods, language, and modes of thought in modern physics, and conversely to introduce physics students to the same things in modern mathematics. Student participation required. Topics change year to year.
1-6 credits, S/U grading

MAT 691 RTG Seminar in Mathematics and Physics II

Intensive learning seminar aimed at first- and second-year graduate students. The main purpose is to introduce mathematics students to the methods, language, and modes of thought in modern physics, and conversely to introduce physics students to the same things in modern mathematics. Student participation is required. Specific topics will change from year to year.
1-6 credits, S/U grading

MAT 696 Mathematics Seminar

1-12 credits, S/U grading
May be repeated for credit

MAT 697 Mathematics Colloquium
1-12 credits, S/U grading
May be repeated for credit

MAT 698 Independent Study
1-12 credits, S/U grading
May be repeated for credit

MAT 699 Dissertation Research On Campus
Dissertation research under direction of advisor.
Prerequisite: Advancement to candidacy (G5); major portion of research must take place on SB campus, at Cold Spring Harbor, or at Brookhaven National Lab.
Fall, spring, and summer, 1-9 credits, S/U grading
May be repeated for credit

MAT 700 Dissertation Research Off Campus— Domestic
Prerequisite: Must be advanced to candidacy (G5); major portion of research will take place off campus, but in the U.S. and/or U.S. provinces (Brookhaven National Lab and Cold Spring Harbor Lab are considered on campus); all international students must enroll in one of the graduate student insurance plans and should be advised by an International Advisor
Fall, spring, and summer, 1-9 credits, S/U grading
May be repeated for credit

MAT 701 Dissertation Research Off Campus— International
Prerequisite: Must be advanced to candidacy (G5); major portion of research will take place outside the U.S. and/or U.S. provinces; domestic students have the option of the health plan and may also enroll in MEDEX; international students who are in their home country are not covered by mandatory health plan and must contact the Insurance Office for the insurance charge to be removed; international students who are not in their home country are charged for the mandatory health insurance (if they are to be covered by another insurance plan, they must file a waiver by the second week of classes; the charge will only be removed if the other plan is deemed comparable); all international students must receive clearance from an International Advisor
Fall, spring, and summer, 1-9 credits, S/U grading
May be repeated for credit

MAT 800 Full-Time Summer Research
0 credit, S/U grading
May be repeated for credit