MAT
Mathematics

MAT 511: Fundamental Concepts of Mathematics
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, 3 credits, Letter graded (A, A-, B+, etc.)

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, 3 credits, Letter graded (A, A-, B+, etc.)

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, 3 credits, Letter graded (A, A-, B+, etc.)

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, 3 credits, Letter graded (A, A-, B+, etc.)

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, 3 credits, Letter graded (A, A-, B+, etc.)

MAT 515: Geometry for Teachers
A re-examination of elementary geometry using concepts from analysis and algebra. Prerequisite: MAT 511
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

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. Prerequisite: MAT 511
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MAT 517: Calculators and Computers for Teachers
Calculators and Computers for teachers. Graphing calculators, programming, computing and curve sketching; Geometers Sketchpad or other computer based classroom tools; educational use of the world wide web. Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MAT 519: Seminar in Mathematics in Teaching and Learning
Seminar format. This course involves deliberative group inquiry - through reading, writing and intensive discussion - into mathematics teaching, learning and mathematics education research; analysis and design of cognitively demanding mathematical tasks; and analysis of students' mathematical thinking, written responses, and common misconceptions in the mathematics classroom. Each student completes an action research project focused on a topic selected with guidance from the instructor.
3 credits, Letter graded (A, A-, B+, etc.)

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, Letter graded (A, A-, B+, etc.)

MAT 531: Topology, Geometry II
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MAT 535: Algebra II
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

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, Letter graded (A, A-, B+, etc.)

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, Letter graded (A, A-, B+, etc.)

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, Letter graded (A, A-, B+, etc.) 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, Letter graded (A, A-, B+, etc.)
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, Letter graded (A, A-, B+, etc.)

MAT 543: Complex Analysis II
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MAT 544: Real Analysis I
Ordinary differential equations; Banach and Hilbert spaces; inverse and implicit function theorems; Lebesgue measure; general measures and integrals; measurable functions; convergence theorems for integrals.
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

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 decomposition 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, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAT 546: Differential Equations
Distributions and the Fourier transform; compact operators, Fredholm theory; pseudodifferential operators; Sobolev spaces; regularity theory for elliptic operators; Hodge theorem.
Prerequisite: MAT 544, Corequisite: MAT 550
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

MAT 550: Real Analysis II
Representations and decomposition theorems in measure theory; Fubini's theorem; Lp 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, Letter graded (A, A-, B+, etc.)

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, Letter graded (A, A-, B+, etc.)

MAT 552: Introduction to Lie Groups and Lie Algebras
Prerequisite: MAT 531, MAT 534
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MAT 555: Introduction to Dynamic 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 the Mandelbrot set, Renormalization, rigidity and universality phenomena, Hamiltonian dynamics and integrability, Kolmogorov-Arnold-Moser Theory (overview), Homoclinic bifurcations and New house phenomenon. 3 credits. Offered in Spring. Prerequisites: MAT 530 and MAT 544.
3 credits, Letter graded (A, A-, B+, etc.)

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, Letter graded (A, A-, B+, etc.)

MAT 566: Differential Topology
Vector bundles, transversality, and characteristic classes. Further topics such as embeddings and immersions, intersection theory, surgery, and foliations.
Prerequisite: MAT 531
Fall, 3 credits, Letter graded (A, A-, B+, etc.)

MAT 569: 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, Letter graded (A, A-, B+, etc.)

MAT 570: Concepts and Methods of Quantum Mechanics
Spring, 3 credits, Letter graded (A, A-, B+, etc.)

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**

**MAT 598: Teaching Practicum**
Seminar and workshop for new teaching assistants.

**Fall, 3 credits, S/U grading**

**MAT 599: M.A. Research**
May be repeated for credit.

**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, Letter graded (A, A-, B+, etc.)**

**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, Letter graded (A, A-, B+, etc.)**

**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, Letter graded (A, A-, B+, etc.)**

**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, Letter graded (A, A-, B+, etc.)**

**MAT 614: Topics in Algebraic Geometry**
Typical topics are drawn from varieties and schemes, algebraic curves, and their arithmetics. Fall

**3 credits, Letter graded (A, A-, B+, etc.)**

**MAT 615: Topics in Algebraic Geometry**
Typical topics are drawn from varieties and schemes, algebraic curves, and their arithmetics. Fall

**3 credits, Letter graded (A, A-, B+, etc.)**

**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**

**Fall, 3 credits, Letter graded (A, A-, B+, etc.)**

**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**

**Fall, 3 credits, Letter graded (A, A-, B+, etc.)**

**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**

**Fall, 3 credits, Letter graded (A, A-, B+, etc.)**

**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**

**Fall, 3 credits, Letter graded (A, A-, B+, etc.)**

**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, Letter graded (A, A-, B+, etc.)**

**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 operators, nonlinear equations.

**Prerequisite: Permission of instructor**

**Fall, 3 credits, Letter graded (A, A-, B+, etc.)**

**MAT 638: Topics in Real Analysis**
Topics selected from functional analysis, harmonic analysis, Banach algebras, operator theory.

**Prerequisite: Permission of instructor**

**Fall, 3 credits, Letter graded (A, A-, B+, etc.)**

**MAT 639: Topics in Real Analysis**
Topics selected from functional analysis, harmonic analysis, Banach algebras, operator theory.

**Prerequisite: Permission of instructor**

**Fall, 3 credits, Letter graded (A, A-, B+, etc.)**

**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, Letter graded (A, A-, B+, etc.)**

**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, Letter graded (A, A-, B+, etc.)
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
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
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
fields 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, Letter graded (A, A-, B+, etc.)
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
fields 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, Letter graded (A, A-, B+, etc.)
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
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
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
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAT 662: Advanced Topics in Algebra
Prerequisite: Permission of instructor
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAT 663: Advanced Topics in Algebra
Prerequisite: Permission of instructor
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAT 666: Advanced Topics in Algebraic Topology
Prerequisite: Permission of instructor
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAT 670: Advanced Topics in Complex Analysis
Prerequisite: Permission of instructor
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAT 671: Advanced Topics in Complex Analysis
Prerequisite: Permission of instructor
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAT 674: Advanced Topics in Differential Equations
Prerequisite: Permission of instructor
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAT 675: Advanced Topics in Differential Equations
Prerequisite: Permission of instructor
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAT 678: Advanced Topics in Real Analysis
Prerequisite: Permission of instructor
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAT 679: Advanced Topics in Real Analysis
Prerequisite: Permission of instructor
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAT 682: Advanced Topics in Differential Geometry
Prerequisite: Permission of instructor
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
May be repeated for credit.

MAT 683: Advanced Topics in Differential Geometry
Prerequisite: Permission of instructor
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
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
tory, geodesic flows, bifurcation theory.
Prerequisite: Permission of instructor
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
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
tory, geodesic flows, bifurcation theory.
Prerequisite: Permission of instructor
Fall, 3 credits, Letter graded (A, A-, B+, etc.)
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 is required.
Specific topics will change from 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
May be repeated for credit.

MAT 697: Mathematics Colloquium
May be repeated for credit.

MAT 698: Independent Study
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 SBU campus, at Cold Spring Harbor, or at the Brookhaven National Lab.

Fall, 1-9 credits, S/U grading
May be repeated for credit.

MAT 800: FULL TIME SUMMER RES
All international students must received clearance from an International Advisor.
Fall, 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 United States and/or U.S. provinces. Please note, Brookhaven National Labs and the 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, 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 of the United States and/or U.S. provinces. Domestic students have the option of the health plan and may also enroll in MEDEX. International students who are not 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 be second week of classes. The charge will only be removed if other plan is deemed comparable.