

# MATHEMATICS

**Office:** Room 4314  
**Phone:** 718.489.5397

## Department Mission

Mathematics belongs both to the sciences and to the liberal arts. Not only is it the language of science, but it is also studied for its own beauty. Its basic elements are logic and intuition, analysis and construction, generality and individuality.

The department of Mathematics strives to promote academic excellence in mathematics and in related fields. It offers a wide spectrum of mathematics courses ranging from first-year courses to upper-level advanced courses that cover the full undergraduate curriculum in mathematics, leading to a B.S. in Mathematics. The challenging B.S. degree program is excellent preparation for graduate study at any university.

The Mathematics major and minor prepare students for careers in business, government, industry, teaching, and research. The rapid advances of science and technology have multiplied the domains in which mathematics is a prerequisite for a variety of applications in modern technologies. In today's technology-oriented climate, the department's graduates have new opportunities for employment and professional advancement.

## Program Student Learning Outcomes:

- PLO 1: Demonstrate proficiency with the techniques and applications of single and multivariate calculus. In particular, students will be able to find limits, derivatives, and integrals of various functions.
- PLO 2: Solve first order differential equations and higher order linear differential equations.
- PLO 3: Understand and write mathematical proofs, producing arguments that are logically and mathematically correct.
- PLO 4: Use probability and statistics to find the likelihood of events and to find the mean and standard deviation of various probability distributions.
- PLO 5: Use matrices to solve systems of linear equations and to study vector spaces and linear transformations.
- PLO 6: Understand, identify, and prove facts about algebraic structures, such as groups, rings, and fields.

## Programs

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## Courses

### **MAT-1101 Quantitative Reasoning (3 Credits)**

A course designed to reinforce and strengthen topics in algebra to improve quantitative reasoning and analytical skills. Students will read and analyze data, create mathematical models, draw inferences, distinguish between linear and non-linear relationships, and support conclusions based on sound mathematical reasoning. Students will use technology to develop an understanding of mathematical algorithms, estimation, problem solving, graphs and charts, and communicate this understanding. This course replaces MAT0500 and 0700, and it serves as the prerequisite for mathematics courses MAT1103 and higher. This course does not fulfill the mathematics requirement in the Core program. Placement by examination.

**Typically offered:** All Sessions

### **MAT-1103 Foundations of Mathematics (3 Credits)**

**Requisite(s):** MAT-1101 or higher

A liberal arts mathematics course for non-mathematics and non-science majors. Explores several ideas of mathematics to give the student an appreciation of the significance of mathematics. The course covers mathematical patterns and problem solving, numeration and mathematical systems, other number bases, the binary number system, modular arithmetic, the Fibonacci sequence and the Golden ratio, and real numbers and their representation.

**Fulfills General Education Requirement:** QR1

**Typically offered:** All Sessions

### **MAT-1104 Discrete Mathematics (3 Credits)**

**Requisite(s):** MAT-1101 or higher

Basic concepts of set theory, symbolic logic, counting methods, permutations and combinations, discrete probability and elementary statistics, graphs, graph theory, Euler circuits, and trees.

**Fulfills General Education Requirement:** QR1

**Typically offered:** All Sessions

### **MAT-1105 College Algebra (3 Credits)**

**Requisite(s):** MAT-1101 or higher

A review of topics in intermediate algebra and an extended treatment of some topics such as relations, functions, and graphs to include polynomial, rational, algebraic, exponential, and logarithmic functions and graphs. Additional topics include linear systems of equations and inequalities in two variables, determinants, and matrices with applications to business and economics. This course is recommended for students with a weak to moderate knowledge of intermediate algebra.

**Fulfills General Education Requirement:** QR1

**Typically offered:** All Sessions

### **MAT-1107 Algebra and Trigonometry for Science Majors (4 Credits)**

**Requisite(s):** MAT-1105 or higher

A course for mathematics and science majors designed to develop and strengthen those topics in algebra and trigonometry that a student should master before taking a first standard course in calculus. Basic concepts from analytic geometry such as circles, ellipses and other conic sections. Roots of polynomials, graphs and transformations of graphs. Graphs of polynomial, and rational functions. Trigonometric identities and equations. The trigonometric and inverse trigonometric functions and their graphs. Graphing calculator is optional.

**Fulfills General Education Requirement:** QR1

**Typically offered:** All Sessions

**MAT-1109 Mathematics for Managerial Science I (3 Credits)****Requisite(s):** MAT-1105 or higher

Basic algebraic concepts such as factorization of polynomials, solving basic algebraic equations. Lines and parabolas. Maxima and minima. Exponentials and logarithms. Compound interest and other exponential models. The study of matrices and their application. Examples include inversion and the solution of systems in linear equations, linear inequalities and linear programming (graphical approach), dual problems, and economic interpretation.

**Fulfills General Education Requirement:** QR1**Typically offered:** Fall Only**MAT-1110 Business Calculus (3 Credits)****Requisite(s):** MAT-1109

Introduces the basic concepts of functional relationships, the basic skills of differentiation and integration, maxima and minima problems, and several other applications of calculus, especially models in business, exponential models, and mathematics of finance.

**Fulfills General Education Requirement:** QR1**Typically offered:** All Sessions**MAT-2202 Calculus I (4 Credits)****Requisite(s):** MAT-1107 or higher

Differential Calculus. Functions, including polynomials, rational and radical functions. Exponential and logarithmic functions. Trigonometric and inverse trigonometric functions. Limits, continuity, differentiation of algebraic and transcendental functions. Applications of the derivative, Fermat's Theorem, Rolle's Theorem, the Mean Value Theorem. Monotone functions, maxima and minima. Asymptotes, Convexity and Concavity and sketching graphs. L'Hopital's rule. course.

**Fulfills General Education Requirement:** QR1**Typically offered:** All Sessions**MAT-2203 Calculus II (4 Credits)****Requisite(s):** MAT-2202

Integral Calculus. Antiderivatives and the indefinite integral. Riemann sums and the definite integral. Properties of the integral and the Fundamental Theorem of Calculus. The logarithm via an integral, exponential, hyperbolic and inverse hyperbolic functions. Methods of integration, including the substitution method and integration by parts. Trigonometric integral and trigonometric substitutions. Integration of rational functions and rationalizing substitutions. Applications of integration, area, length, surface area and volume. Polar coordinates. Improper integrals.

**Fulfills General Education Requirement:** QR1**Typically offered:** All Sessions**MAT-2301 Statistics (3 Credits)****Requisite(s):** MAT-1104 or higher

Organization, description, and interpretation of data. Probability and probability distributions. Sampling distributions and estimation of population parameters. Testing hypotheses, linear regression, correlation analysis, and index numbers.

**Fulfills General Education Requirement:** QR1**Typically offered:** All Sessions**MAT-2309 College Geometry (3 Credits)****Requisite(s):** MAT-2202

Topics of higher Euclidean geometry and geometric constructions. Geometrical transformations and different kinds of geometries. Projective and hyperbolic geometries.

**Typically offered:** As Needed**MAT-3304 Calculus III (4 Credits)****Requisite(s):** MAT-2203

Sequences and Series of real numbers. Vectors and vector-valued functions. Functions of several variables. Limits and continuity. The derivative, directional and partial derivatives. Chain rule. Maxima, minima, Lagrange's multipliers. Double and triple integrals, cylindrical and spherical coordinates and change of variable formula. Applications.

**Typically offered:** All Sessions**MAT-3305 Calculus Workshop Using Technology (3 Credits)****Requisite(s):** MAT-2202, MAT-2203

A treatment of the basic notions of calculus using computer and mathematical software programs, for example, Derive 6<sup>™</sup>, "Mathematica", etc. The course covers problems involving limits, derivatives, graphs, approximation of solutions. and approximation of series and integrals. Lab Fee.

**Typically offered:** All Sessions**MAT-3310 Vector Analysis (3 Credits)****Requisite(s):** MAT-3304

The algebra and calculus of vectors, scalar and vector product, coordinate systems, space geometry, vector differential operators, divergence and curl of vector fields, curvilinear coordinates, line and surface integrals. Green's theorem, Stokes' theorem, and divergence theorem.

**Typically offered:** As Needed**MAT-3311 Introduction to Set Theory (3 Credits)****Requisite(s):** MAT-2203

The algebra of propositions and quantifiers; sets, relations, functions, equivalence relations, partial and total orders, and product sets; Cantor hypothesis, cardinal and ordinal numbers, and well-ordered sets; Axiom of Choice, Zorn's dilemma, and well ordering axiom.

**Typically offered:** As Needed**MAT-3312 Linear Algebra (4 Credits)****Requisite(s):** MAT-2203

Systems of linear equations, vector spaces, linear independence basis and dimension; matrices and determinants, rank and nullity; eigenvalues and eigenvectors; diagonalizable matrices; linear transformations and matrices.

**Typically offered:** Fall Only**MAT-3401 Differential Equations I (3 Credits)****Requisite(s):** MAT-2203

Methods of solving ordinary differential equations with applications. Linear differential equations of first-, second-, and higher-order applications. Systems of linear differential equations.

**Typically offered:** Fall Only**MAT-3406 Theory of Numbers (3 Credits)****Requisite(s):** MAT-2202

An introductory course dealing with divisibility, number theorems, theory and congruences, quadratic residues, and Diophantine equations. Quadratic residues and quadratic reciprocity law. Fermat's theory, Chinese remainder theorem, Euler's theorem, and Wilson's theorem.

**Typically offered:** As Needed

**MAT-4000 Topic in Advanced Mathematics: Analysis (3 Credits)****Requisite(s):** MAT 4404 and approval of chairperson.

Special topics investigate select problems in Mathematics. Topic is announced in advance. Examples include Topics in Algebra: Solvability by radicals, Galois groups, and polynomial equations not solvable by radicals. The Sylow theorems and the fundamental theorem of Algebra; and Topics in Analysis: Banach and Hilbert spaces, linear operators and special classes of operators, self-adjoint and normal operators. Elements of spectral theory. The Fourier transform. The Banach fixed-point theorem. Applications to differential and integral equations.

**Typically offered:** On Demand**MAT-4001 Special Topics in Mathematics Topics in Cryptography (3 Credits)****Requisite(s):** MAT 4404 and approval of chairperson.

The course explores basic types of attack; ciphers such as substitution ciphers, Hill ciphers, as well as Number Theory related problems such as congruence equations and modular exponentiation.

**Typically offered:** On Demand**MAT-4402 Differential Equations II (3 Credits)****Requisite(s):** MAT-3401

Fourier series and Laplace transformations: applications. Series solution of differential equations. Legendre's and Bessel's equations. Partial differential equations.

**Typically offered:** As Needed**MAT-4403 Advanced Calculus I (4 Credits)****Requisite(s):** MAT-3304

Real numbers, axiom of continuity, least upper bounds, and greatest lower bounds; open and closed sets; continuity differentiation; maxima and minima for functions of two or more variables; the method of Lagrange; implicit function theorems; and general theorems of partial differentiation.

**Typically offered:** Fall Only**MAT-4404 Advanced Calculus II (4 Credits)****Requisite(s):** MAT-4403

The theory of Riemann integration in one and many variables. Multiple integrals, Fubini's Theorem, the change of variable theorem. Improper multiple integrals. Integrals depending on a parameter, the Gamma and Beta functions. Sequences and Series of functions, uniform convergence, power series.

**Typically offered:** Spring Only**MAT-4408 Numerical Analysis (3 Credits)****Requisite(s):** MAT-3304 or MAT-3401

Numerical solutions of equations, difference tables, operator methods; numerical differentiation and integration; numerical solution of ordinary differential equations; systems of linear equations; solutions by iterative methods.

**Typically offered:** As Needed**MAT-4409 Modern Algebra (3 Credits)****Requisite(s):** MAT-3304

Sets and mappings; theory of groups, rings, and fields; homomorphisms, isomorphisms, and the first isomorphism theorem for groups and rings; the field of real/ complex numbers. Polynomials.

**Typically offered:** All Sessions**MAT-4410 Functions of a Complex Variable (3 Credits)****Requisite(s):** MAT-3304

Complex numbers and the topology of the complex plane; analytic and elementary functions, contour integrals, conformal mappings, power series, Laurent series, Cauchy-Riemann partial differential equations; Cauchy-Goursat theorem.

**Typically offered:** As Needed**MAT-4411 Introduction to Real Analysis (3 Credits)****Requisite(s):** MAT-4404

Families of sets, countable and uncountable sets, metric spaces, the space of continuous functions on a compact set, the Stone-Weierstrass theorem, measure and measurable functions, the Lebesgue Integral, and dominated and monotone convergence theorem,  $L_p$  Spaces.

**Typically offered:** As Needed**MAT-4413 Advanced Linear Algebra (3 Credits)****Requisite(s):** MAT-3312

Advanced course in linear algebra examining linear transformations and matrices, the characteristics and minimal polynomials, Cayley-Hamilton theorem, diagonalization, unitary spaces, self-adjoint, normal matrices and the spectral theorem, Jordan canonical form, and quadratic form.

**Typically offered:** As Needed**MAT-4414 General Topology (3 Credits)****Requisite(s):** MAT-4403

Set-theoretic preliminaries, metric spaces, topological spaces, continuity and homomorphism, compactness and connectedness, separation axioms, complete metric spaces, and covering spaces.

**Typically offered:** As Needed**MAT-4415 Probability Theory (3 Credits)****Requisite(s):** MAT-3304

Discrete and continuous random variables and their probability distributions. Mathematical expectation and moments. Chebyshev's Theorem, the Bernoulli, Poisson, Geometric, and Hypergeometric distributions; the Uniform, Exponential, Gamma, Chi-Square, and Normal distribution. Multivariate probability distributions. Functions of random variables. Central Limit theorems.

**Typically offered:** Fall Only**MAT-4416 Mathematical Statistics II (3 Credits)****Requisite(s):** MAT-4415

Sampling distributions, methods of estimation and hypothesis, linear regression, and the method of least squares. Correlation and analysis of variance. Elements of decision theory, statistical games, and nonparametric tests.

**Typically offered:** As Needed**MAT-4418 Senior Seminar (3 Credits)****Requisite(s):** MAT-3304, MAT-2203

Advanced problem-solving seminar for students interested in taking the GRE subject mathematics Exam for graduate studies or in taking the Examination given by the Society of Actuaries. According to the needs of the students, this seminar covers material from calculus, differential equations, complex variables and advanced calculus, or number theory, modern algebra and linear algebra or calculus, probability theory and mathematical statistics.

**Typically offered:** As Needed**MAT-4995 Independent Study in Mathematics (1-4 Credits)****Requisite(s):** Senior Standing and Departmental approval.

Independent study under the direction of a faculty member in the Mathematics department. For students majoring in Mathematics Education, the independent study is on the history of mathematics.

**Typically offered:** On Demand

**MAT-5400 The Infinite (3 Credits)**

Cross-listed with: PHI-5402. The infinite is a rich and dynamic notion situated at the crossroads of several fields of study and reflection. This team-taught interdisciplinary seminar approaches the infinite from two distinct perspectives: that of philosophy, and that of mathematics.

**Fulfills General Education Requirement:** NPW, PEM

**Typically offered:** As Needed

## **Faculty Chairperson**

Dr. Fotios Paliogiannis

## **Professor**

Paliogiannis

## **Associate Professor**

Shochat

## **Assistant Professor**

Ciungu  
Kyriakou

## **Lecturer**

Bam  
Malijan

## **Professor Emeritus**

Andres

## **Adjuncts**

Camilien  
Hajra  
Hayasaka  
Kaganovskiy  
Norasteh  
Obiang  
Saint-Jean  
Seaton  
Zaderman