

# **NYU**Mathematics

UNDERGRADUATE PROGRAM

ACADEMIC YEAR 2011 – 2012  
(Revised October 2011)

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This guide is meant to provide majors with a comprehensive picture of the offerings of the Mathematics Department. It contains information on courses, degree requirements, special programs, activities, prizes and awards. It supplements and repeats the information contained in the New York University Bulletin for the College of Arts and Sciences.

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## 1. Welcome To The Mathematics Department

The undergraduate division of the Department of Mathematics offers a wide variety of courses in pure and applied mathematics. The faculty are members of the University's Courant Institute of Mathematical Sciences, noted for its advanced training and research programs, which emphasize the applications of mathematics to technology and other branches of science.

In accordance with the Institute's philosophy, emphasizing the applications of mathematics to technology and other branches of science, the department participates in many interdisciplinary programs. Joint programs are available in mathematics and (1) computer sciences, (2) economics, (3) engineering and (4) minor in mathematics secondary school education. They lead to the B.A. in four years, with the exception of the engineering option, which leads to a joint B.S./B.S. degree from NYU and NYU-Poly. Additionally, an accelerated B.A. and M.S. degree in Mathematics from New York University in five years is offered. These programs are described in more detail below. Special courses in the mathematical aspects of finance, biology, and medicine are also available.

The department provides an honors program in (1) mathematics and (2) mathematics and computer science for outstanding students. Additionally, independent study courses are available for students with special interests. Qualified undergraduates are granted an opportunity to enroll in courses in the graduate division of the department. All students have access to the Institute's library which houses a large, up-to-date collection of books and technical journals in mathematics and computer science. The library is located on the twelfth floor of the Courant Institute.

## 2. Advising

Students intending to major in mathematics are urged to declare their major as early as possible and no later than the beginning of their junior year. Students can declare their major by completing a major declaration form which is found on the undergraduate mathematics website: [math.nyu.edu/degree/undergrad/](http://math.nyu.edu/degree/undergrad/).

The Undergraduate Advisement office for the Department is located in room 626 of Warren Weaver Hall. All matters concerning mathematics courses, mathematics majors and minors can be addressed here. When necessary, the Program Administrator will arrange appointments with the Director of Undergraduate Studies or Vice Chair of Undergraduate Affairs for advisement

or academic counseling. Each mathematics major is assigned to a faculty advisor in the mathematics department. All declared mathematics majors must have their proposed course schedules approved each term by his/her faculty advisor. The approved schedule must be signed by their faculty advisor and delivered to the mathematics department administrative staff in room 626 or 627 for final clearance.

Students who believe that they are prepared to start their work in mathematics at an advanced level, or who feel qualified to enter a course without the formal prerequisites, should submit a documentation of prior college level coursework along with syllabuses to the Vice Chair of Undergraduate Affairs. Students who have not taken college level coursework but feel that they are prepared to enroll in advanced courses may be asked to demonstrate proficiency by taking a final examination in the prerequisite course for their desired course. Placement exams are offered each semester.

### **3. Degree Programs**

**Major in Mathematics.** The requirements for a mathematics major are twelve courses numbered MATH-UA 120 or higher. The only exception is Introduction to MATH-UA 246 Abstract Algebra which counts for the mathematics minor *only*. The courses must include:

- A. MATH-UA 121 (or placement beyond it)
- B1. MATH-UA 122, MATH-UA 123 III, and MATH-UA 140 Linear Algebra OR
- B2. MATH-UA 221-22 Honors Calculus I, II
- C. MATH-UA 325 Analysis I
- D. MATH-UA 343 Algebra I
- E. MATH-UA 326 Analysis II OR MATH-UA 344 Algebra II OR MATH-UA 224 Vector Analysis
- F. Electives to a total of 12 courses

*It is strongly suggested for students to take MATH-UA 325 Analysis I before enrolling in MATH-UA 343 Algebra I.*

In addition, the student must maintain a 2.0 mathematics GPA.

The sequence MATH-UA 221, MATH-UA 222 Honor Calculus I and II is counted as two courses; it covers material from MATH-UA 122, 123 and 140 Calculus II, III and Linear Algebra. Therefore, students enrolling in honors calculus are expected to have a solid background in MATH-UA 121 Calculus I.

Any two computer science courses numbered CSCI-UA 101 or higher may be credited toward the 12 course requirement. Students who complete the Pre-

medical or Pre-dental Program and who wish to major in mathematics may count any two of the following courses toward their 12 course mathematics requirement: PHYS-UA 11 and 12 General Physics I and II or PHYS-UA 91 and 93 Physics I and II. However, if these physics courses are used towards the mathematics major, the computer sciences courses will not apply towards the major. Courses taken under the pass/fail option cannot be counted toward the major.

**Joint Major in Mathematics and Computer Science.** An interdisciplinary major offered jointly by the Department of Mathematics and Computer Science, provides the opportunity to study both computer science and relevant mathematics courses such as analysis, algebra, probability, and statistics. Eight computer science courses are required for the major. Please refer to the undergraduate computer science website for more information about the computer science courses:

<http://cs.nyu.edu/web/Academic/Undergrad/>

The mathematics requirements are ten courses numbered MATH-UA 120 or higher from the Mathematics Department, which must include MATH-UA 325 Analysis I and MATH-UA 343 Algebra I; MATH-UA 246 Intro to Abstract Algebra cannot be counted if MATH-UA 343 Algebra I is applied toward the major. The remaining mathematics courses must include one of the following: MATH-UA 326 Analysis II, MATH-UA 344 Algebra II, or MATH-UA 224 Vector Analysis.

**Joint Major in Mathematics and Economics.** An interdisciplinary major is offered for studies jointly by the Departments of Mathematics and Economics, providing the opportunity to study economics, computer science, and in mathematics, analysis, statistics, and operations research. Please note: Students in the joint mathematics/economics major may only take the theory sequence.

The mathematics requirements are nine courses consisting of MATH-UA 121 – 123 Calculus I, II, III, MATH-UA 140 Linear Algebra, MATH-UA 325, 326 Analysis I, II plus three courses chosen below:

MATH-UA 224 Vector Analysis	MATH-UA 262 Ordinary Differential Equations
MATH-UA 235 Probability & Statistics	MATH-UA 363 Partial Differential Equations
MATH-UA 240 Combinatorics	MATH-UA 264 Chaos & Dynamical Systems
MATH-UA 141 Honors Linear Algebra	MATH-UA 248 Theory of Numbers
MATH-UA 343, 344 Algebra I, II	MATH-UA 233 Theory of Probability
MATH-UA 234 Mathematical Statistics	MATH-UA 250 Mathematics of Finance
MATH-UA 252 Numerical Analysis	MATH-UA 270 Transformations & Geometries
MATH-UA 282 Functions of a Complex Variable	

The economics requirements are 9 courses in Economics including: ECON-UA 5, ECON-UA 6, ECON-UA 11, ECON-UA 13, ECON-UA 20, ECON-UA 266, plus any three economics elective courses, at least two of which must be theory electives numbered ECON-UA 300 to ECON-UA 399.

Please refer to the undergraduate economics website for more information about the economics courses: <http://econ.as.nyu.edu/page/ugprog>.

A grade of C or better is required in all of these courses.

**Mathematics Minor.** The requirement for a mathematics minor is four courses in the department numbered MATH-UA 120 or higher. Only two of these courses may apply simultaneously to the requirements for any other major. At most two mathematics courses in the minor may be transferred from other colleges. Courses taken under the pass/fail option are not counted toward the minor. A grade of C or better is required in all courses applied to the minor.

**Joint Mathematics and Computer Science Minor.** The requirements are the four courses MATH-UA 121, MATH-UA 122, CSCI-UA 101 and CSCI-UA 102. A grade of C or better is required. At most one mathematics course in the joint minor may be transferred from other colleges.

**Advanced Mathematical Methods Minor.** The Advanced Mathematical Methods Minor (for Stern undergraduates) provides students with mathematical tools to handle complex business problems. The requirements are MATH-UA 140, STAT-UB 14, MATH-UA 252 or MATH-GA 2010, and one of these advanced courses: MATH-UA 262, MATH-UA 263, STAT-UB 15, STAT-UB 21, or MATH-UA 325. Note: All students must take at least one Stern course in order to meet minor requirements. If a student has completed the CAS version of Probability, STAT-UB 14 should not be taken. Instead, please select one of the following: STAT-UB 15 or STAT-UB 21. Students who have the equivalent of MATH-UA 140 should substitute a more advanced course from the list above.

**Mathematics Education Minor for Mathematics Majors.** The Mathematics Education Minor (for Mathematics Majors) enables you to complete coursework as an undergraduate in CAS that will reduce the number of credits required of a Steinhardt School of Education M.A. degree in Teachers of Mathematics, Grades 7-12 that will fulfill the requirements for Initial teacher certification. The master's degree will require 30 credits including student teaching internships beyond the bachelor's degree.

It is recommended that you declare the minor and begin taking these courses during your first semester of junior year. Most of these courses require a fieldwork component consisting of classroom observation and participation. For course descriptions, please see the current Steinhardt School of Education's Undergraduate website at:  
<http://steinhardt.nyu.edu/teachlearn/minors/general>

**B.S. /B.S. Program in Engineering.** The College of Arts and Science, in cooperation with the Polytechnic Institute of NYU, offers a joint B.S./B.S. program in engineering. Students in the program receive the B.S. degree in mathematics from New York University and the B.S. degree from Polytechnic in either civil, computer, electrical or mechanical engineering. The joint mathematics/engineering students must complete the 12-course mathematics requirement. Students are allowed to substitute CSCI-UA 101, 102 Computer Science I, II, or PHYS-UA 91, 93 Physics I, II for a maximum of two mathematics classes. Further information is available from Joseph Hemmes, the coordinator of the B.S./B.E. program, in the College Advising Center, Silver Center, 100 Washington Square East, Room 905, (212) 998-3133.

**B.A./M.S. Program in Mathematics.** New York University has introduced a program that allows students to obtain a Mathematics Bachelor's and Master's degree in five years. The program is suited to students who have decided not to enter a Ph.D. program at this time but who would like to increase their skills before entering the job market. Qualifying students are accepted into a program toward the end of the sophomore year or during their junior year before they reach 96 credits. Students must earn a minimum of a 3.50 GPA in order to qualify for acceptance into the joint B.A. /M.A. For more information, please contact advisor Dr. Justin Lorts the CAS Advising Center at (212) 998-8521. During the last few undergraduate semesters students should accelerate by taking one quarter of their graduate courses during regular terms and/or during the summer.

#### **4. Honors Program**

**Mathematics Honors Major.** The Honors Program is designed for students with a strong commitment to mathematics. It is recommended for students who intend to pursue graduate study in mathematics. Beyond the major core requirements, an honors major must take: MATH-UA 325, 326 Analysis I, II and MATH-UA 343, 344 Algebra I, II, both usually taken during the junior year; and MATH-UA 393, 394 Honors, I-II, are usually taken in the senior year. Under special circumstances, with the permission of the department, certain graduate courses may be substituted for Honors I-II. Potential honors students should register for MATH-UA 221-222 Honors Calculus I, II. These

courses cover materials from MATH-UA 122, 123, and 140 Calculus II – III and Linear Algebra, knowledge of MATH-UA 121 Calculus I is required. Although it is recommended, these Honors Calculus courses are not required for this program.

Students must also complete a senior research project. Students should register for two semesters of MATH-UA 997, 998 independent study under faculty supervision. Students should seek approval of their research project from the Director of Undergraduate Studies or Vice Chair of Undergraduate Affairs. The research project can also be completed through the mathematics summer research program (S.U.R.E.). Students are required to present their research at the undergraduate research forum in the fall semester of their senior year.

Students seeking admission into the honors program must: **1.)** maintain a grade point average of 3.65 or higher in the major sequence (including Honors requirements), **2.)** maintain a general grade point average of 3.65 or better, and **3.)** obtain approval of the director of the honors program. Interested students can consult with the mathematics Honors Advisor, Professor Elie Hameiri at [hameiri@cims.nyu.edu](mailto:hameiri@cims.nyu.edu).

**Joint Honors in Mathematics and Computer Sciences.** This is an interdisciplinary major offered by the Department of Mathematics and the Department of Computer Science.

The mathematics requirements include:

MATH-UA 120 Discrete Mathematics  
MATH-UA 121, 122, 123 Calculus I, II, III  
MATH-UA 140 Linear Algebra  
MATH-UA 325, 326 Analysis I, II  
MATH-UA 343, 344 Algebra I, II  
MATH-UA 393, 394 Honors I, II  
(MATH-UA 393 and MATH-UA 394 may be substituted for two graduate classes with mathematics faculty approval).

The computer science requirements include:

CSCI-UA 101, CSCI-UA 102, CSCI-UA 201, CSCI-UA 202, CSCI-UA 310, CSCI-UA 421, CSCI-UA 453, and three computer science courses listed at the CSCI-UA 400 level. Four courses, numbered CSCI-UA 101 to CSCI-UA 499, must be completed with HONORS credit, one of which must be CSCI-UA 300-level or above.

Students should complete a guided research, sponsored by either department and presented at the Dean's Undergraduate Research Conference which takes place in late April. Students are expected to dedicate 10-20 hours per week toward their research.

**Latin Honors.** To graduate with Latin honors, a student must have completed at least 64 points in courses in the College with passing grades. All graded courses taken while enrolled in the College, or in other divisions of the University, will be used to compute the honors average. Pass/Fail grades are not counted, nor are grades received in courses at other institutions. The student must have a good record of conduct and maintain a minimum general average as follows: cum laude, 3.50; magna cum laude, 3.70; summa cum laude, 3.90.

## 5. Transfer Students

Transfer students who have taken mathematics courses at other colleges should consult the Vice Chair for Undergraduate Affairs as soon as possible to determine proper placement. They should bring copies of their transcripts along with syllabi including course description, schedule of topics, assessment plan, and textbook title and author for all mathematics courses taken elsewhere. Transfer courses that are to be counted toward major or optional minor requirements must be judged equivalent to courses currently taught by the mathematics department. Credit can only be transferred from institutions offering a bachelor's degree in mathematics. Credit cannot be transferred for courses in which a majority of the assessment is conducted in a distance-learning environment. Official transcripts must also be sent to the University registrar's office.

To graduate with a major in mathematics, transfer students must complete at least 12 eligible mathematics courses, each with grade of C or better. At least half the courses comprising the major must be taken in the College of Arts and Science at New York University during two or more semesters. For the minor in mathematics, at least two of the four required mathematics courses must be taken in residence at the College of Arts and Science at New York University, and cannot be applied towards major or minor requirements in other departments.

## 6. Courses Offered in Academic Year 2011 - 2012

FALL		SPRING	
Discrete Mathematics	MATH-UA 120	Discrete Mathematics	MATH-UA 120
Calculus I	MATH-UA 121	Calculus I	MATH-UA 121
Calculus II	MATH-UA 122	Calculus II	MATH-UA 122
Calculus III	MATH-UA 123	Calculus III	MATH-UA 123
Linear Algebra	MATH-UA 140	Linear Algebra	MATH-UA 140
Honors Linear Algebra I	MATH-UA 141	Honors Linear Algebra II	MATH-UA 142
Honors Calculus I	MATH-UA 221	Mathematics for Economics I	MATH-UA 211
Theory of Probability	MATH-UA 233	Honors Calculus II	MATH-UA 222
Theory of Numbers	MATH-UA 248	Vector Analysis	MATH-UA 224
Mathematics of Finance	MATH-UA 250	Fundamental Dynamics of Earth	MATH-UA 228
Mathematics in Medicine and Biology	MATH-UA 255	Mathematical Statistics	MATH-UA 234
Ordinary Differential Equations	MATH-UA 262	Probability & Statistics	MATH-UA 235
Transformations and Geometry	MATH-UA 270	Combinatorics	MATH-UA 240
Analysis I	MATH-UA 325	Intro to Abstract Algebra (only for minors & Mathematics Ed)	MATH-UA 246
Analysis II	MATH-UA 326	Intro to Mathematical Modeling	MATH-UA 251
Algebra I	MATH-UA 343	Numerical Analysis	MATH-UA 252
Topology	MATH-UA 375	Computers in Medicine and Biology	MATH-UA 256
Special Topics I	MATH-UA 393	Ordinary Differential Equations	MATH-UA 262
Independent Study	MATH-UA 997	Partial Differential Equations	MATH-UA 263
		Chaos and Dynamical Systems	MATH-UA 264
		Functions of a Complex Variable	MATH-UA 282
		Analysis I	MATH-UA 325
		Analysis II	MATH-UA 326
		Algebra I	MATH-UA 343
		Algebra II	MATH-UA 344
		Special Topics II	MATH-UA 394
		Independent Study	MATH-UA 998

- *MATH-UA 240 Combinatorics is offered every spring.*
- *MATH-UA 270 Transformations and Geometry is offered every fall.*
- *MATH-UA 395-96 Special Topics subjects and prerequisites are announced and posted in advance.*
- *MATH-UA 393-94 Honors topics are announced and posted in advance.*
- *The mathematics department rarely offers Logic courses due to low enrollment. However, if students wish to take a Logic course offered by the Philosophy Department, they should consult the Vice Chair of Undergraduate Affairs to seek approval for the course to count towards the mathematics*

major.

## 7. Suggested Course Programs

The programs shown below are suggestions only. Many students will take more mathematics electives than are listed in these programs.

### A. Possible program for mathematics majors:

YEAR	FALL	SPRING
First Year	MATH-UA 121 (Calculus I)	MATH-UA 122 (Calculus II)
Second Year	MATH-UA 123 (Calculus III)	MATH-UA 140 (Linear Algebra) Mathematics Elective
Third Year	MATH-UA 325 (Analysis I) Mathematics Elective	MATH-UA 326 (Analysis II) or MATH-UA 343 (Algebra I) Mathematics Elective
Fourth Year	MATH-UA 343 (Algebra I) Mathematics Elective	Mathematics Elective MATH-UA 326 (Analysis II) or MATH-UA 344 (Algebra II)

*By the end of the seventh semester students should complete Analysis I, Algebra I, and one or more proofs courses.*

### B. Possible program for mathematics majors who intend to go into secondary school education:

YEAR	FALL	SPRING
First Year	MATH-UA 121 (Calculus I)	MATH-UA 122 (Calculus II)
Second Year	MATH-UA 123 (Calculus III)	MATH-UA 140 (Linear Algebra)
Third Year	MATH-UA 233 (Probability) Mathematics Elective	Mathematics Elective Mathematics Elective
Fourth Year	MATH-UA 270 (Tranfs&Geom) MATH-UA 325 (Analysis I)	Mathematics Elective Mathematics Elective

Recommended electives are MATH-UA 120 (Discrete Mathematics), MATH-UA 255 (Mathematics in Medicine and Biology), MATH-UA 248 (Theory of Numbers), MATH-UA 264 (Chaos & Dynamical Systems), MATH-UA 262 (Ordinary Differential Equations), and MATH-UA 282 (Function of Complex Variables).

### C. Possible Honors Program. (Especially recommended for students who intend to go to graduate school for advanced work in mathematics).

YEAR	FALL	SPRING
First Year	MATH-UA 221 (Honor Cal. I)	MATH-UA 222 (Honor Cal. II)
Second Year	MATH-UA 262 (Ordinary Diff. Equations)	MATH-UA 325 (Analysis I)
Third Year	MATH-UA 343 (Algebra I) MATH-UA 326 (Analysis II)	MATH-UA 326 (Analysis II) MATH-UA 344 (Algebra II)
Fourth Year	MATH-UA 393 (Honors I) Elective	MATH-UA 394 (Honors II) Elective

Students with advanced standing should begin their freshman year at the appropriate level. Highly qualified students are encouraged to take graduate mathematics courses provided they satisfy the prerequisites and obtain permission from both undergraduate and graduate departmental advisors.

## **8. Activities**

**Mathematics Club** - There is an active mathematics club open to all students interested in the study of mathematics. An organizational meeting is held shortly after classes begin in the fall to plan for the coming academic year. Activities include talks by faculty and guest speakers on a variety of topics including mathematics and career opportunities as well as attending conferences. The club is under the supervision of Professor Adi Rangan.

**William Lowell Putnam Competition** - The mathematics Department participates in the annual William Lowell Putnam Competition, a mathematics competition open to all undergraduate mathematics students in the U.S.A. and Canada. Interested students should contact the department as early as possible in the school year since the contest takes place in early December. A series of preparation sessions is held under the supervision of mathematics faculty.

**Mathematical Contest in Modeling** - MCM is a contest where teams of undergraduates use mathematical modeling to present their solutions to real world problems. Interested students should contact the department as early as possible in the school year.

**Peer Mentor Program** - The mathematics department has an active peer mentor program for mathematics majors. The program is designed to assist new mathematics majors in making the transition to the mathematics major and life at NYU. If you're interested in becoming a mentor or mentee please send an email to [dugs@cims.nyu.edu](mailto:dugs@cims.nyu.edu).

## **9. Awards**

**Prizes.** Each year the Sidney Goldwater Roth Prize is presented to the graduating senior who has been of greatest service to the department and his or her fellow students, and who shows the greatest promise in mathematics.

- Four awards, two senior and two junior, are awarded for excellence in mathematics and/or for service to the department and fellow students.

- The Hollis Cooley Memorial Prize is awarded for excellence and exceptional promise in mathematics.
- The Perley Lenwood Thorne Medal, endowed by the faculty to honor Professor Thorne at the time of his retirement in 1949, is awarded for outstanding scholarship in mathematics.

**Scholarships and Grants.** New York University sponsors and administers a wide variety of financial aid programs, including its own scholarship and grant funds and some New York State and Federal funds. For additional information, refer to the College of Arts and Science Bulletin.

## 10. Work Opportunities in the Mathematics Department

**Tutoring.** The department offers paid undergraduate tutoring positions for advanced mathematics majors. Tutors provide free tutoring for undergraduate students taking lower level mathematics courses. Preferred applicants have completed and received at least a B+ in Calculus I, II, III and Linear Algebra, and Analysis I.

**Grading.** Paid grader positions are available for advanced mathematics majors. Students grade homework problems for undergraduate mathematics courses. Preferred applicants have completed and received at least a B in Calculus I, II, III, Linear Algebra, and Discrete Mathematics.

Applications are available online at  
<http://math.nyu.edu/degree/undergrad/opportunities.html>

## 11. Course Descriptions

Listed below are descriptions of all mathematics courses that satisfy the major and minor requirements. Some of the courses are given only in the fall, others only in the spring, a few are given once every other year, and some only on request. However, any course may be scheduled if there is sufficient demand.

MATH-UA 120 Discrete Mathematics (offered each term)

Prerequisite: Passing MATH-UA 121 with a grade of C or better, or permission of the department. 4 points. A first course in discrete mathematics. Sets, algorithms, induction. Combinatorics. Graphs and trees. Combinatorial circuits. Logic and Boolean algebra.

Calculus Tracks: Two tracks are currently available: The standard track (MATH-UA 121 - 0123) and the honors track (MATH-UA 221 -0222). The honors track assumes that the student knows the material from Calculus I, as the track covers Calculus II and III along with Linear Algebra. The courses MATH-UA 221 - 0222 are worth 5 credits each and count as the equivalent of three mathematics courses, as it will satisfy a student's Calculus and Linear Algebra requirements. The student, however, must still meet the indicated credit requirement associated with his or her major.

*For more information about Honors Calculus please visit the Honors Calculus website:* [http://math.nyu.edu/degree/undergrad/honors\\_calculus.html](http://math.nyu.edu/degree/undergrad/honors_calculus.html).

While it is possible in some circumstance to switch tracks, it is neither advised nor encouraged. Thus, a student who intends to take the full calculus sequence should be prepared to continue on the same track to complete the sequence. Hand calculators are optional in all sections.

MATH-UA 121 Calculus I (offered each term)

Prerequisite: Passing Departmental placement exam, Advanced Placement scores: AB 4 or better (3 or better starting in 2012) or BC 3 or better, SAT math score of 750 or ACT math score of 34 or Algebra & Calculus (MATH-UA 009) with a grade of C or better. 4 points. Derivatives, antiderivatives, and integrals of functions of one real variable. Trigonometric, inverse trigonometric, logarithmic and exponential functions. Applications, including graphing, maximizing and minimizing functions. Areas and volumes.

MATH-UA 122 Calculus II (offered each term)

Prerequisite: Passing Departmental placement exam, Advanced Placement scores: AB 4 or better or BC 4 or better, or passing MATH-UA 121 with a grade of C or better, or the equivalent. 4 points. Techniques of integration. Further applications. Plane analytic geometry. Polar coordinates and parametric equations. Infinite series, including power series.

MATH-UA 123 Calculus III (offered each term)

Prerequisite: Passing Departmental placement exam, Passing MATH-UA 122 with a grade of C or better, or the equivalent. 4 points. Functions of several optimization and variables. Vectors in the plane and space. Partial derivatives with applications, especially Lagrange multipliers. Double and triple integrals. Spherical and cylindrical coordinates. Surface and line integrals. Divergence, gradient and curl. Theorem of Gauss and Stokes.

MATH-UA 140 Linear Algebra (offered each term)

Prerequisite: Passing MATH-UA 121 with a grade of C or better, or the equivalent. 4 points. Systems of linear equations, Gaussian elimination,

matrices, determinants, Cramer's rule. Vectors, vector spaces, basis and dimension, linear transformations. Eigenvalues, eigenvectors, and quadratic forms.

MATH-UA 141 Honors Linear Algebra I. Identical to MATH-GA 2110. (offered fall term) NOTE: The graduate course is offered in spring under a different name. Prerequisite: A grade of B or better in MATH-UA 325 and/or MATH-UA 343 or the equivalent. 4 points.

Linear spaces, subspaces, and quotient spaces; linear dependence and independence; basis and dimensions. Linear transformation and matrices; dual spaces and transposition. Solving linear equations. Theory of Determinants. Quadratic forms and their relation to local extrema of multivariable functions.

MATH-UA 142 Honors Linear Algebra II Identical to MATH-GA 2120. (offered spring term) Prerequisite: MATH-UA 141. 4 points. Spectral theory, eigenvalues and eigenvectors; nilpotent operations and Jordan canonical form. Inner products orthogonality, theory of bilinear forms. Self-adjoint mappings, matrix inequalities, polar decomposition. Normed linear spaces and the exponential map. Implicit function theorem and introduction to Lie groups.

MATH-UA 211, 212 Mathematics for Economics I and II (Offered each term) Prerequisites: MATH-UA 121 with a grade of C or better, or equivalent.. 4 points.

Elements of calculus and linear algebra are important to the study of economics. This class is designed to provide the appropriate tools for study in the policy concentration. Examples and motivation are drawn from important topics in economics. Topics covered include derivatives of functions of one and several variables; interpretations of the derivatives; convexity; constrained and unconstrained optimization; series, including geometric and Taylor series; ordinary differential equations; matrix algebra; eigenvalues; and (possibly) dynamic optimization and multivariable integration.

MATH-UA 221-222 Honors Calculus I, II (offered fall and spring terms, respectively) Honors Calculus I

*Accelerated Calculus with Linear Algebra I* (offered fall term)

Prerequisite: Placement exam or a score of 4 or higher on the Advanced Placement Calculus BC exam or 5 on the AB exam. 5 points. This is the first semester of a yearlong course that covers the essential content of Calculus II, Calculus III, and Linear Algebra. The first 1/3 semester discusses sequences and series, Taylor's theorem and power series. The next 1/3 semester

introduces concepts from linear algebra including: linear systems of equations; matrices and LU decomposition; determinants; vector spaces; eigenvalues and eigenvectors. The last 1/3 semester introduces topics from vector calculus including: functions of several variables; vector-valued functions; partial derivatives; various applications including maxima and minima.

## Honors Calculus II

*Accelerated Calculus with Linear Algebra* (offered spring term)

Prerequisite: Honors Calculus I with a B or better. 5 points. This is the second semester of a year-long course that covers the essential content of Calculus II, Calculus III and Linear Algebra. Topics covered in the spring are multidimensional differentiation (e.g. differentials, gradients, Taylor expansions, applications), multidimensional integration (e.g. double and triple integrals, Green's theorem, divergence theorem, applications), differential equations (e.g. first-order linear equations, second-order linear equations, applications), and additional topics in linear algebra (e.g. inner products, orthogonality, applications).

## MATH-UA 224 Vector Analysis (offered spring term)

Prerequisite: MATH-UA 325 with a grade of C or better. 4 points. Brief review of multivariate calculus: partial derivatives, chain rule, Riemann integral, change of variables, line integrals. Lagrange multipliers. Inverse and implicit function theorems and their applications. Introduction to calculus on manifolds: definition and examples of manifolds, tangent vectors and vector fields, differential forms, exterior derivative, line integrals and integration of forms. Gauss' and Stokes' theorems on manifolds.

## MATH-UA 233 Theory of Probability (offered fall term)

Prerequisite: MATH-UA 123 with a grade of C or better and/or the equivalent. 4 points. An introduction to the mathematical treatment of random phenomena occurring in the natural, physical, and social sciences. Axioms of mathematical probability, combinatorial analysis, binomial distribution, Poisson and normal approximation, random variables and probability distributions, generating functions, Markov chains, applications.

## MATH-UA 234 Mathematical Statistics (offered spring term)

Prerequisite: MATH-UA 233 with a grade of C or better and/or the equivalent. Not open to students who have taken MATH-UA 235. 4 points. An introduction to the mathematical foundations and techniques of modern statistical analysis for the interpretation of data in the quantitative sciences. Mathematical theory of sampling; normal populations and distributions; chi-

square, t, and F distributions; hypothesis testing; estimation; confidence intervals; sequential analysis; correlation, regression; analysis of variance. Applications to the sciences.

MATH-UA 235 Probability and Statistics (offered spring term)

Prerequisite: MATH-UA 122 with a grade of C or better and/or the equivalent. Not open to students who have taken MATH-UA 233. 4 points. A combination of MATH-UA 233 and MATH-UA 234 at a more elementary level, so as to afford the student some acquaintance with both probability and statistics in a single term. In probability: mathematical treatment of chance; combinatorics; binomial, Poisson, and Gaussian distributions; law of large numbers and the normal approximation; application to coin-tossing, radioactive decay, etc. In statistics: sampling; normal and other useful distributions; testing of hypotheses; confidence intervals; correlation and regression; applications to scientific, industrial, and financial data.

MATH-UA 240 Combinatorics (offered spring term)

Prerequisite: MATH-UA 122 with a grade of C or better and/or the equivalent. 4 points. Techniques for counting and enumeration including generating functions, the principle of inclusion and exclusion, and Polya counting. Graph theory. Modern algorithms and data structures for graph-theoretic problems.

MATH-UA 243 Introduction to Cryptography. Identical to CSCI-UA 480

(offered spring term) Prerequisite: CSCI-UA 310 with a grade of C or better or permission of the instructor. 4 points.

An introduction to both the principles and practice of cryptography and its application to network security. Topics include: symmetric-key encryption (block ciphers, modes of operations, AES); message authentication (pseudorandom functions, CBC-MAC); public-key encryption (RSA, ElGamal); digital signatures (RSA, Fiat-Shamir); authentication applications (identification, zero-knowledge) and others time permitting.

MATH-UA 246 Abstract Algebra (offered spring term)

Prerequisite: MATH-UA 122 and MATH-UA 140 with a grade of C or better. 4 points. An introduction to the main concepts, constructs, and applications of modern algebra. Groups, transformation groups, Sylow theorems and structure theory; rings, polynomial rings and unique factorization; introduction to fields and Galois theory.

NOTES: This course does not count toward the mathematics major because of its considerable overlap with the more intensive Algebra I, MATH-UA 243, required as part of the majors program in Mathematics. It is, however, accepted toward the mathematics minor, and is a strongly recommended

course in the Steinhardt Mathematics Ed major.

MATH-UA 248 Theory of Numbers (offered fall term)

Prerequisite: MATH-UA 122 with a grade of C or better and/or the equivalent. 4 points. Divisibility theory and prime numbers. Linear and quadratic congruences. The classical number-theoretic functions. Continued fractions. Diophantine equations. RSA cryptography algorithm.

MATH-UA 250 Mathematics of Finance (offered fall term)

Prerequisite: MATH-UA 123 and one of the followings MATH-UA 233/MATH-UA 235/ECON-UA 18/ECON-UA 120 (Theory of Probability, Probability & Statistics, Statistics or Analytical Statistics) with a grade of C or better and/or the permission of the instructor. 4 points. Introduction to the mathematics of finance. Topics include: Linear programming with application. Interest rates and present value. Basic probability: random walks, central limit theorem, Brownian motion, lognormal model of stock prices. Black-Scholes theory of options. Dynamic programming with application to portfolio optimization.

MATH-UA 251 Introduction to Mathematical Modeling (offered spring term)

Prerequisites: MATH-UA 123 with a grade of C or better or permission of the instructor. 4 points. Formulation and analysis of mathematical models. Mathematical tool include dimensional analysis, optimization, simulation, probability, and elementary differential equations. Applications to biology, sports, economics, and other areas of science. The necessary mathematical and scientific background will be developed as needed. Students will participate in formulating models as well as in analyzing them.

MATH-UA 252 Numerical Analysis (offered spring term)

Prerequisites: MATH-UA 123 and MATH-UA 140 with a grade of C or better or permission of the instructor. 4 points. In numerical analysis one explores how mathematical problems can analyzed and solved with a computer. As such, numerical analysis has very broad applications in mathematics, physics, engineering, finance, and the life sciences. This course introduces the subject for mathematics majors. Theory and practical examples using Matlab are combined in the studying of topics ranging from simple root-finding procedures to differential equations and the finite element method.

MATH-UA 255 Mathematics in Medicine and Biology. Identical to BIOL-GA 1501.

(offered fall term)

Prerequisite: MATH-UA 121 and BIOL-UA 11 or permission of the instructor. 4 points. Intended primarily for premedical students with interest and ability in mathematics. Topics of medical importance using mathematics as a tool: control of the heart, optimal principles in the lung, cell membranes,

electrophysiology, countercurrent exchange in the kidney, acid-base balance, muscle, cardiac catheterization, computer diagnosis. Material from the physical sciences and mathematics is introduced as needed and developed within the course.

MATH-UA 256 Computers in Medicine and Biology. Identical to BIOL-GA 1502 (offered spring term)

Prerequisites: MATH-UA 255 or permission of the instructor. Familiarity with a programming language such as Pascal, FORTRAN, or BASIC is recommended. 4 points. Introduces the students of biology or mathematics to the use of the computer as a tool for modeling physiological phenomena. Each student constructs two computer models selected from the following list: circulation, gas exchange in the lung, control of cell volume, and the renal countercurrent mechanism. The student uses the models to conduct simulated physiological experiments.

MATH-UA 262 Ordinary Differential Equations (offered each term)

Prerequisites: MATH-UA 123 and MATH-UA 140 with a grade of C or better or the equivalent. 4 points. First and second order equations. Series solutions. Laplace transforms. Introduction to partial differential equations and Fourier series.

MATH-UA 263 Partial Differential Equations (offered spring term)

Prerequisite: MATH-UA 262 with a grade of C or better or the equivalent. 4 points. Many laws of physics are formulated as partial differential equations. This course discusses the simplest examples, such as waves, diffusion, gravity, and static electricity. Non-linear conservation laws and the theory of shock waves are discussed. Further applications to physics, chemistry, biology, and population dynamics.

MATH-UA 264 Chaos and Dynamical Systems (offered fall term)

Prerequisite: MATH-UA 122 and MATH-UA 140 with a grade of C or better or the equivalent. 4 points. Topics to include fixed points of one dimensional maps, linear operators and linear approximations; stability and bifurcation; logistic maps, Cantor sets, fractal sets, symbolic dynamics, conjugacy of maps. Introduction to dynamics in two dimensions. Introduction for students with little preparation to the recent discovery that, in certain regimes, fully deterministic mechanics can produce chaotic behavior.

MATH-UA 270 Transformations and Geometries (offered fall term)

Prerequisite: MATH-UA 123 with a grade of C or better or the equivalent. 4 points. An axiomatic and algebraic study of Euclidean, non-Euclidean, affine, and conformal and projective geometries. Special attention to group

theoretic methods and the use of complex variables.

MATH-UA 282 Functions of Complex Variable (offered spring term)

Prerequisites: MATH-UA 123 and MATH-UA 140 plus one higher level course with the grade of C or better. 4 points. Complex numbers and complex functions. Differentiation and the Cauchy-Riemann equations. Cauchy's theorem and the Cauchy integral formula. Singularities, residues, and Laurent series. Fractional Linear transformations and conformal mapping. Analytic continuation. Applications to fluid flow etc.

MATH-UA 325 Analysis I (offered each term)

Prerequisite: MATH-UA 122, MATH-UA 123 and MATH-UA 140 or the equivalent. 4 points. The real number system. Convergence of sequences and series. Rigorous study of functions of one real variable: continuity, connectedness, compactness, metric spaces, power series, uniform convergence and continuity.

MATH-UA 326 Analysis II (offered spring term)

Prerequisite: MATH-UA 325 or permission of the department. 4 points. Functions of several variables. Limits and continuity. Partial derivatives. The implicit function theorem. Transformation of multiple integrals. The Riemann integral and its extensions.

MATH-UA 343 Algebra I (offered each term)

Prerequisites: MATH-UA 123 and MATH-UA 140 with a grade of C or better and/or the equivalent. *It is strongly recommended to take MATH-UA 325 before registering for this course.* 4 points. Groups, homomorphisms, automorphisms, permutation groups. Rings, ideals and quotient rings, Euclidean rings, polynomial rings.

MATH-UA 344 Algebra II (offered spring term)

Prerequisite: MATH-UA 343 with a grade of C or better. 4 points. Extension fields, roots of polynomials. Construction with straight-edge and compass. Elements of Galois theory.

MATH-UA 375 Topology (offered fall term)

Prerequisite: MATH-UA 325 or permission of the department. 4 points. Set-theoretic preliminaries. Metric spaces, topological spaces, compactness, connectedness, covering spaces, and homotopy groups.

MATH-UA 377 Differential Geometry (offered spring upon request)

Prerequisite: MATH-UA 326 or permission of the department. 4 points. The differential properties of curves and surfaces. Introduction to differential

manifolds and Riemannian geometry.

MATH-UA 393, 394 Honors I-II. Topic varies from year to year (offered each term)

Prerequisite: Approval of the director of the honors program. 4 points each term. Complex numbers; analytic functions, Cauchy-Riemann equations; linear fractional transformations; construction and geometry of the elementary functions; Green's theorem, Cauchy's theorem; Jordan curve theorem, Cauchy's formula; Taylor's theorem, Laurent expansion; analytic continuation; isolated singularities, Liouville's theorem; Abel's convergence theorem and the Poisson integral formula.

MATH-UA 395, 396 Special Topics I-II (offered upon request)

Prerequisite: Permission of the department. 4 points each term. Covers topics not offered regularly; experimental courses and courses offered on student demand. Detailed course descriptions are available during preregistration.

MATH-UA 997, 998 Independent Study (offered each term)

Prerequisite: Permission of the department. 2 or 4 points each term. To register for this course a student must complete an application form for Independent Study and have the approval of a faculty sponsor and the Director of Undergraduate Studies or the Vice Chair for Undergraduate Affairs.

## **12. Graduate Courses Open to Undergraduates**

Qualified students may take the courses listed below in the Graduate School of Arts and Science provided they first obtain permission from both undergraduate and graduate departmental advisors. If these courses are offered toward fulfillment of the requirements for the baccalaureate degree, no advanced credit is allowed for them in the graduate school. These courses are all three credit courses.

MATH- GA 2010, 2020 Numerical Methods

MATH-GA 2111 Linear Algebra (for students who have not taken MATH-UA 142)

MATH-GA 2043 Scientific Computing

MATH-GA 2130, 2140 Algebra

MATH-GA 2210, 2220 Number Theory

MATH-GA 2310, 2320 Topology

MATH-GA 2430, 2440 Real Variables

MATH-GA 2470 Ordinary Differential Equations  
MATH-GA 2701, 2702 Introduction to Applied Mathematics  
MATH-GA 2731, 2742 Game Theory, Linear Programming  
MATH-GA 2850, 2851 Mathematical Topics in Biology  
MATH-GA 2911, 2912 Basic Probability  
MATH-GA 2350, 2360 Differential Geometry I-II

### **13. Departmental Faculty**

Marco M. Avellaneda. Professor. Licenciado en Ciencias 1981, Buenos Aires; Ph.D. 1985, Minnesota. Research interests: applied mathematics, mathematical modeling in finance, probability.

Gerard Ben Arous. Professor. Ph.D. 1981, University of Paris. Research interests: probability theory, stochastic processes, partial differential equations.

Marsha J. Berger. Professor. B.A. 1974, SUNY (Binghamton); M.A. 1978, Ph.D. 1982, Stanford. Research interests: computational fluid dynamics, adaptive methods for partial differential equations, parallel computing.

Fedor A. Bogomolov. Professor. Diploma 1970, Moscow University; Ph.D. 1974, Steklov Institute of Mathematics. Research interests: algebraic geometry and related problems in algebra, topology, number theory.

Oliver Bühler. Associate Professor. Ph.D. 1996, Cambridge University. Research interests: geophysical fluid dynamics, interactions between waves and vortices, acoustics, statistical mechanics.

David Cai. Professor. B.S. 1984, Peking University; M.S. 1989, Ph.D. 1994, Northwestern. Research interests: nonlinear stochastic behavior in physical and biological systems.

Sylvain E. Cappell. Professor. B.A. 1966, Columbia; Ph.D. 1969, Princeton. Research interests: algebraic and geometric topology, symplectic and algebraic geometry.

Sourav Chatterjee. Associate Professor. Ph.D. 2005, Stanford. Probability theory, stochastic processes, mathematical physics and theoretical statistics. Specific current interests: Stein's method, spin glasses, central limit theorems, random matrix theory.

Jeff Cheeger. Professor. B.A. 1964, Harvard College; M.S. 1966, Ph.D. 1967, Princeton. Research interests: differential geometry and its connections to analysis and topology.

Yu Chen. Associate Professor. B.S. 1982, Tsinghua University; M.S. 1988, Ph.D. 1991, Yale. Research interests: numerical scattering theory, ill-posed problems, scientific computing.

Percy A. Deift. Professor. B.S. 1967, M.S. 1970, Natal, Durban; M.S. 1971, Rhodes South Africa; Ph.D. 1976, Princeton. Research interests: spectral theory and inverse spectral theory, integrable systems, Riemann-Hilbert problems.

Aleksandar Donev. Assistant Professor of Mathematics. Multi-scale (hybrid) methods; fluctuating hydrodynamics; coarse-grained particle methods; jamming and packing

Edwin Gerber. Assistant Professor of Mathematics and Atmosphere/Ocean Science. Ph.D. 2005, Princeton; B.S. 2000, The University of the South. Research interests: Atmospheric dynamics,

climate variability, stochastic modeling.

Pierre Germain Assistant Professor, MS 2001, PhD 2006 Ecole polytechnique. Research interests: nonlinear partial differential, harmonic analysis.

Jonathan B. Goodman. Professor. B.S. 1977, Massachusetts Institute of Technology; Ph.D. 1982, Stanford. Research interests: fluid dynamics, computational physics, computational finance.

Leslie Greengard. Professor. B.A. 1979, Wesleyan; M.D. 1987, Ph.D. 1987, Yale. Research interests: applied and computational math, partial differential equations, computational chemistry, mathematical biology.

Frederick P. Greenleaf. Professor. B.S. 1955 Pennsylvania State; M.A. 1961, Ph.D. 1964, Yale. Research interests: noncommutative harmonic analysis, Lie groups and group representations, invariant partial differential operators.

Mikhael Gromov. Professor. Maitrise 1965, Doctorat 3e Cycle 1969, D.Sc. 1973, University of Leningrad. Research interests: Riemannian manifolds, symplectic manifolds, infinite groups, math models of biomolecular systems.

Sinan Gunturk. Associate Professor. B.S. 1996, Bogazici University; Ph.D. 2000, Princeton. Research interests: harmonic analysis, information theory, signal processing.

Larry Guth. Professor. Ph.D. 2005, MIT. Research interests: metric geometry, harmonic analysis, combinatorial geometry.

Eliezer Hameiri. Professor. B.A. 1970, M.A. 1972, Tel Aviv; Ph.D. 1976, New York. Research interests: applied mathematics, magnetohydrodynamics, plasma physics.

Alexander Hanhart. Clinical Assistant Professor. Topological and Geometric methods in Mathematical Physics, Scientific Computing.

Fengbo Hang. Associate Professor. B.S. 1993, Tsinghua University; M. S. 1996, Peking University; Ph.D. 2001, New York University. Research interests: Geometric analysis and nonlinear partial differential equations.

David Holland. Professor. B.S. 1984, B.A. 1993, M.S. 1986, Memorial University (Newfoundland); Ph.D. 1993, McGill. Research interests: ocean-ice studies, climate theory and modeling.

Selin Kalaycioglu. Clinical Assistant Professor, Ph.D. 2009 University of Arizona. Research interests: Computational group theory, representation theory of finite groups and algebras, math education.

Richard Kleeman. Professor. B.S. 1980, Australian National University, Ph.D. 1986, Adelaide University. Research interests: climate dynamics, El Nino, predictability of weather and climate dynamical systems.

Bruce Kleiner Professor. Research interests: Geometric analysis, geometric group theory and geometric evolution equations.

Robert V. Kohn. Professor. A.B. 1974, Harvard; M.S. 1975, Warwick (England); Ph.D. 1979, Princeton. Research interests: nonlinear partial differential equations, materials science, mathematical finance.

Petter N. Kolm. Clinical Associate Professor and Deputy Director of the Mathematics in Finance

Masters Program. M.S. (Diplommathematiker) 1994, ETH Zurich; M.Phil. (Tekn. Lic.) 2000, Royal Institute of Technology; Ph.D. 2000, Yale University. Research interests: financial econometrics, financial mathematics, optimization, quantitative trading, portfolio and risk management.

Matthew Leingang. Clinical Associate Professor. Ph.D. 2000, Harvard. Research interests: Mathematics Education, Web Pedagogies, differential geometry.

Fang-Hua Lin. Professor. B.S. 1981, Zhejiang; Ph.D. 1985, Minnesota. Research interests: partial differential equations, geometric measure theory.

Andrew Majda. Professor. B.S. 1970, M.S. 1971, Ph.D. 1973, Stanford. Research interests: modern applied mathematics, atmosphere/ocean science, partial differential equations.

Nader Masmoudi. Professor. Ph.D. 1999, University of Paris Dauphine. Research interests: nonlinear parallel differential equations.

Henry P. McKean. Professor. B.A. 1952, Dartmouth; Ph.D. 1955, Princeton. Research interests: probability, partial differential equations, complex function theory.

David W. McLaughlin. Professor. B.S. 1966, Creighton. M. S. 1969, Ph.D. 1971, Indiana University. Research interests: applied mathematics, nonlinear wave equations, visual neural science.

Bhubaneswar Mishra. Professor. B.Tech 1980, Indian Institute of Technology; M.S. 1982, Ph.D. 1985, Carnegie Mellon. Research interests: robotics, genomics, finance, mathematical and theoretical computer science.

Assaf Naor. Associate Professor. B. S. 1996, M.S. 1998, Ph.D. 2002, Hebrew University. Research interests: analysis, probability; applications to combinatorics, mathematical physics, and theoretical computer science.

Charles M. Newman. Professor. B.S. 1966, Massachusetts Institute of Technology; M.A. 1968, Ph.D. 1971, Princeton. Research interests: probability theory, statistical physics, stochastic models.

Michael Overton. Professor. B.S. 1974, British Columbia; M.S. 1977, Ph.D. 1979, Stanford. Research interests: numerical linear algebra, optimization, linear and semi-definite programming.

Olivier Pauluis. Assistant Professor. B.S./M.S. 1995, Université Catholique de Louvain; Ph.D. 2000, Princeton. Research interests: climate and the general circulation of the atmosphere, moist convection, tropical meteorology, numerical modeling.

Jerome K. Percus. Professor. B.S. 1947, M.A. 1948, Ph.D. 1954, Columbia. Research interests: chemical physics, mathematical biology.

Charles S. Peskin. Professor. B.A. 1968, Harvard; Ph.D. 1972, Yeshiva. Research interests: applications of mathematics and computing to problems in medicine and biology, cardiac fluid dynamics, molecular machinery within biological cells, mathematical/computational neuroscience.

Aaditya Rangan. Assistant Professor. B.A. 1999, Dartmouth; Ph.D. 2003 California (Berkeley). Research interests: Large-scale scientific modeling of physical biological, and neurobiological phenomena.

Weiqing Ren. Associate Professor. B.S., 1994, University of Nanjing; Ph.D. 2002, NYU. Research interests: applied mathematics, scientific computing, multiscale modeling of fluids.

John Rinzel. Professor. B.S. 1967, University of Florida; M.S. 1968, Ph.D. 1973, New York. Research interests: computational neuroscience, nonlinear dynamics of neurons and neural circuits, sensory processing.

Sylvia Serfaty. Professor. M.S. 1995, Ecole Normale Superieure; Ph.D. 1999, University of Paris-Orsay. Research interests: partial differential equations, nonlinear analysis applied to physics.

Jalal M. I. Shatah. Professor. B.S. 1979, Texas (Austin); Ph.D. 1983, Brown. Research interests: partial differential equations, analysis.

Michael J. Shelley. Professor. B.A. 1981, Colorado; M.S. 1984, Ph.D. 1985, Arizona. Research interests: applied math and modeling, visual neuroscience, fluid dynamics, computational physics and neuroscience.

K. Shafer Smith. Associate Professor. B.S. 1992, Indiana; Ph.D. 1999, UC Santa Cruz. Research interests: geophysical fluid dynamics, physical oceanography and climate.

Joel H. Spencer. Professor. B.S. 1965, Massachusetts Institute of Technology; Ph.D. 1970, Harvard. Research interests: discrete mathematics, theoretical computer science.

K.R. Sreenivasan. Professor of Physics and Mathematics; Senior Vice Provost, NYU; Research interest: turbulence, complex fluids, cryogenic helium and nonlinear dynamics.

Daniel Stein. Professor. Sc.B. 1975, Brown University; M.A. 1977, Ph.D. 1979, Princeton University. Research interests: theoretical condensed matter physics, statistical mechanics, and mathematical physics.

Esteban G. Tabak. Professor. Bach. 1988, University of Buenos Aires; Ph.D. 1992, Massachusetts Institute of Technology. Research interests: dynamics of the atmosphere and ocean, energy transfer in systems with many degrees of freedom.

Daniel A. Tranchina. Professor. B.A. 1975, SUNY (Binghamton); Ph.D. 1981, Rockefeller. Research interests: mathematical modeling in neuroscience.

Yuri Tschinkel. Professor. M.A. 1990, Moscow State University; Ph.D. 1992, Massachusetts Institute of Technology. Research interests: algebraic geometry, number theory, automorphic forms.

Kirył Tsishchanka. Clinical Assistant Professor. Research interests: number theory.

Mark Tygert. Assistant Professor of Mathematics. Computational science and engineering, particularly numerical analysis.

Eric Vanden-Eijnden. Professor. B. S., M. S., 1992, Ph.D. 1997, Universite Libre de Bruxelles. Research interests: stochastic partial differential equations, statistical mechanics, turbulence theory.

S. R. Srinivasa Varadhan. Professor. B.S. 1959, M.A. 1960, Madras; Ph.D. 1963, Indian Statistical Institute. Research interests: probability theory, stochastic processes, partial differential equations.

Harold Weitzner. Professor. B.A. 1954, California; M.A. 1955, Ph.D. 1958, Harvard. Research interests: plasma physics, fluid dynamics, differential equations.

Olof B. Widlund. Professor. M.S. 1960, Ph.D. 1964, Royal Institute of Technology (Stockholm); D. Phil. 1966, Upsala. Research interests: numerical analysis, partial differential equations, parallel

computing.

Lai-Sang Young. Professor. B.A. 1973, Wisconsin; M.A. 1976, Ph.D. 1978, California (Berkeley).  
Research interests: dynamical systems and ergodic theory.

Jun Zhang. Associate Professor. B.S. 1985, Wuhan University (China); Ph.D. 1994, University of  
Copenhagen. Research interests: fluid dynamics, biophysics, complex systems.