NYUMathematics

UNDERGRADUATE PROGRAM

ACADEMIC YEAR 2013 – 2014
(Revised October 2013)

New York University
Mathematics Department
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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: http://www.math.nyu.edu/degree/undergrad/declaring.html.

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. Calculus placement exams are offered each semester.

3. Degree Programs

Major in Mathematics. The requirements for the mathematics major are twelve courses numbered MATH-UA 120 or higher. The only exceptions are MATH-UA 246 Abstract Algebra which counts for the mathematics minor *only,* and MATH-UA 211, 212, and 213 Math for Economics I, II and III which are not open to anyone who has taken Calculus and are for Economics Majors. The courses must include: (Please see below for the requirements for students who entered NYU before Fall 2012)

- MATH-UA 121 Calculus I
- MATH-UA 122 Calculus II, MATH-UA 123 Calculus III, and MATH-UA 140 Linear Algebra,

OR

- MATH-UA 221, 222 Honors Calculus I, II (these courses cover the material for MATH-UA 122, 123 and 140)
- MATH-UA 325 Analysis I
- MATH-UA 343 Algebra I

The rest of the 12 required courses must include two of the following:

- MATH-UA 326 Analysis II
- MATH-UA 344 Algebra II
- MATH-UA 224 Vector Analysis
- MATH-UA 233 Theory of Probability
- MATH-UA 252 Numerical Analysis
- MATH-UA 263 Partial Differential Equations
- MATH-UA 282 Functions of a Complex Variable

AND

- Four 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 enrolled in and who complete the Premedical or Predental Program and who wish to major in mathematics may substitute at most two math classes by any two of the following; PHYS-UA 11 and 12 General Physics I and II or PHYS-UA 91 and 93 Physics I, II toward their 12 course requirement. 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 are not counted toward the major. A grade of C or better is required in all courses used to fulfill the major requirement.

***** Requirements for students who entered NYU before Fall 2012 *****

A. MATH-UA 121 (or placement beyond it)
B1. MATH-UA 122 Calculus II, MATH-UA 123 Calculus III, and MATH-UA 140 Linear Algebra,
OR
B2 . MATH-UA 221, 222 Honors Calculus I, II (these courses cover the material for MATH-UA 122, 123 and 140)
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. Five 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. (Please see below for the requirements for students that entered NYU prior to Fall 2012)

The requirements are ten courses numbered MATH-UA 120 or higher from the Mathematics Department, which must include:

- MATH-UA 120 Discrete Math
- MATH-UA 121 Calculus I
- MATH-UA 122 Calculus II
- MATH-UA 123 Calculus III
- MATH-UA 140 Linear Algebra
- MATH-UA 325 Analysis I
- MATH-UA 343 Algebra I
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The rest of the 10 required courses must include two of the following:

- MATH-UA 326 Analysis II
- MATH-UA 344 Algebra II
- MATH-UA 224 Vector Analysis
- MATH-UA 233 Theory of Probability
- MATH-UA 252 Numerical Analysis
- MATH-UA 263 Partial Differential Equations
- MATH-UA 282 Functions of a Complex Variable

and eight computer science courses as required for the major in that department. Please refer to the undergraduate computer science website for information on computer science courses:

http://www.cs.nyu.edu/csweb/Academic/Undergrad/majors.html

* A grade of C or better is required in all these courses to fulfill the major requirement

***** Requirements for students who entered NYU before Fall 2012 ******

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. (Please see below for requirements for students who entered NYU prior to Fall 2013)

The requirements are nine courses numbered MATH-UA 120 or higher from the Mathematics Department, which must include:

- MATH-UA 211 Math for Economics I
- MATH-UA 212 Math for Economics II
- MATH-UA 213 Math for Economics III
- MATH-UA 140 Linear Algebra
- MATH-UA 325 Analysis I

Plus four chosen from:

- MATH-UA 141 Honors Linear Algebra
- MATH-UA 224 Vector Analysis
- MATH-UA 233 Theory of Probability
- MATH-UA 234 Mathematical Statistics
- MATH-UA 235 Probability & Statistics
- MATH-UA 240 Combinatorics
- MATH-UA 248 Theory of Numbers
- MATH-UA 250 Mathematics of Finance
- MATH-UA 252 Numerical Analysis
- MATH-UA 262 Ordinary Differential Equations
- MATH-UA 263 Partial Differential Equations
- MATH-UA 264 Chaos & Dynamical Systems
- MATH-UA 270 Transformations & Geometries
- MATH-UA 282 Function of Complex Variables
- MATH-UA 326 Analysis II
- MATH-UA 343 Algebra I
- MATH-UA 344 Algebra II

The economics requirements are ECON-UA 1, 2, 11, 13, 20, 266, plus any two economics elective courses, which must be theory electives numbered ECON-UA 3XX and one which must be numbered ECON-UA 2XX. Please refer to the undergraduate

economics website for information on economics courses:
http://www.econ.nyu.edu/undergrad/jointmajors307.html

**** Requirements for students who entered NYU before Fall 2013 ****

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

MATH-UA 224 Vector Analysis
MATH-UA 235 Probability & Statistics
MATH-UA 240 Combinatorics
MATH-UA 141 Honors Linear Algebra
MATH-UA 343, 344 Algebra I, II
MATH-UA 234 Mathematical Statistics
MATH-UA 252 Numerical Analysis
MATH-UA 282 Functions of a Complex Variable
MATH-UA 262 Ordinary Differential Equations
MATH-UA 363 Partial Differential Equations
MATH-UA 264 Chaos & Dynamical Systems
MATH-UA 248 Theory of Numbers
MATH-UA 233 Theory of Probability
MATH-UA 250 Mathematics of Finance
MATH-UA 270 Transformations & Geometries
MATH-UA 326 Analysis II

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 Mr. Joseph Hemmes, adviser for the B.S./B.S. program, in the College Advising Center, Silver Center, 100 Washington Square East, Room 905; 212-998-8160**.**

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. 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. In the graduate portion of the program, they can qualify for a scholarship covering up to 50 percent of the tuition for the master's degree. For more information, please contact Associate Director, Juniors and Inter-School Programs, Scott Statland at scott.statland@nyu.edu or (212) 998-8521.

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, which are MATH-UA 121, 122, 123, Calculus I, II, and III, and MATH-UA 140, Linear Algebra, 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; MATH-UA 393, 394 Honors, I-II, are usually taken in the senior year; and three electives, numbered MATH-UA 120 or higher. Under special circumstances, with the permission of the department, certain graduate courses may be substituted for Honors I-II. Potential honors students are strongly encouraged to register for Honors Calculus I and II, if they have the necessary prerequisites. However, Honors Calculus I and II are not mandatory for participation in the honors 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 who participate in this program 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)** 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.

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 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 places 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. Effective with the September 2008 graduating class, the GPA cutoffs for each category are determined by the combined GPA distribution from the preceding academic year, all graduation moments included. The cutoff for summa cum laude is the GPA included within the top 5 percent of the previous year's graduating class. The cutoff for magna cum laude is the GPA included within the next 10 percent of the previous year's class. The cutoff for cum laude is the GPA included within the next 15 percent of the previous year's class. For example, the necessary GPA level for summa cum laude for students graduating in September 2008 will be based on the GPA cutoff for the top 5 percent of the combined graduates from September 2007, January 2008, and May 2008.

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 2013 – 2014

FALL		SPRING	
Algebra and Calculus	MATH-UA 9	Algebra and Calculus	MATH-UA 9
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	Set Theory	MATH-UA 130
Honors Linear Algebra I	MATH-UA 141	Linear Algebra	MATH-UA 140
Math for Economics I	MATH-UA 211	Honors Linear Algebra II	MATH-UA 142
Math for Economics II	MATH-UA 212	Intro. to Computer Simulation	MATH-UA 144
Math for Economics III	MATH-UA 213	Math for Economics I	MATH-UA 211
Honors Calculus I	MATH-UA 221	Math for Economics II	MATH-UA 212
Theory of Probability	MATH-UA 233	Math for Economics III	MATH-UA 213
Theory of Numbers	MATH-UA 248	Honors Calculus II	MATH-UA 222
Mathematics of Finance	MATH-UA 250	Vector Analysis	MATH-UA 224
Mathematics in Medicine and Biology	MATH-UA 255	Earth's Atmosphere and Fluid Dynamics	MATH-UA 228
Ordinary Differential Equations	MATH-UA 262	Introduction to Fluid Dynamics	MATH-UA 230
Transformations and Geometry	MATH-UA 270	Theory of Probability	MATH-UA 233
Analysis I	MATH-UA 325	Mathematical Statistics	MATH-UA 234
Analysis II	MATH-UA 326	Probability and Statistics	MATH-UA 235
Algebra I	MATH-UA 343	Combinatorics	MATH-UA 240
Algebra II	MATH-UA 344	Abstract Algebra	MATH-UA 246
Honors I	MATH-UA 393	Intro to Mathematical Modeling	MATH-UA 251
Independent Study	MATH-UA 997	Numerical Analysis	MATH-UA 252
		Computers in Medicine and Biology	MATH-UA 256
		Ordinary Differential Equations	MATH-UA 262
		Partial Differential Equations	MATH-UA 263
		Chaos and Dynamical Systems	MATH-UA 264
		Functions of 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
		Topology	MATH-UA 375
		Honors II	MATH-UA 394
		Independent Study	MATH-UA 998

• MATH-UA 240 Combinatorics is offered every spring.

• 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.

• MATH-UA 211, 212 and 246 do not count towards the Math Major degree.

• MATH-UA 211, 212, and 213 are for Economics Majors (if they are double majoring in Math they may use these instead of Calculus I – III)

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)	MATH-UA 326 (Analysis II) or MATH-UA 343 (Algebra I)
	Mathematics Elective	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)	Mathematics Elective
	MATH-UA 325 (Analysis I)	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)	MATH-UA 394 (Honors II)
	Elective	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 Society - 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 Elizabeth Stepp.

Association for Women in Mathematics - The mission and purpose of AWM – NYU Chapter is to increase interest in the mathematical sciences and their applications in various industries. More specifically, it focuses on mentoring, encouraging and bringing together women undergraduates in mathematics to increase visibility of women and their contributions in the discipline.

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.

Interdisciplinary Contest in Modeling - The Interdisciplinary Contest in Modeling (ICM) is an international contest for high school students and college undergraduates. ICM is an extension of the Mathematical Contest in Modeling (MCM). It is designed to develop and advance interdisciplinary problem-solving skills as well as competence in written communication. Registration for ICM is via MCM.

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 beth@cims.nyu.edu.

Study Abroad - NYU undergraduates can spend a semester studying abroad at one of the many centers run by NYU Global Programs. Currently, mathematics can be studied at NYU Berlin and NYU London. If you are interested in participating in any of these programs, please contact the study abroad office.

S.U.R.E. Program - Since the spring 2000 semester the Mathematics Department has sponsored a number of summer research experiences (S.U.R.E.) for a selected number of undergraduate math majors. The Summer Undergraduate Research Experience is aimed at advanced undergraduate math students in their junior year. The project ends with a written report and an oral presentation in the beginning of the fall semester. Funds to support this activity are limited and student participants are chosen by a faculty committee based on grades, coursework, and fit between their research interests and those of the supervising faculty. Applications are considered more highly if students have found a faculty mentor and research topic.

9. Awards

Prizes - Every spring the mathematics department presents awards to exceptional students in the department.

- Mathematics Awards 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 an A in Calculus I, II, III, 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, and Linear Algebra.

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 9 Algebra and Calculus (offered each term) – 4 points
Prerequisites:
High school mathematics or permission of the department.

An intensive course in intermediate algebra and trigonometry. Topics include algebraic, exponential, logarithmic, and trigonometric functions and their graphs.

MATH-UA 120 Discrete Mathematics (offered each term) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 121 Calculus I or MATH-UA 212 Math for Economics II (for Economics Majors), or permission of the department.

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 of MATH-UA 121-123 Calculus I, II, and III and MATH-UA 221 – 222 Honors I, II track. 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 – 222 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.
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.

MATH-UA 121 Calculus I (offered each term) – 4 points
Prerequisite:

a. a score of 650 or higher on the mathematics portion of the SAT
b. a score of 650 or higher on the SAT Subject Test in Mathematics 1
c. a score of 650 or higher on the SAT Subject Test in Mathematics 2
d. an ACT mathematics score of 30 or higher
e. a score of 3 or higher on the AP Calculus AB exam

f. a score of 3 or higher on the AP Calculus BC exam
g. A level Maths score of C or higher (anyone who took Further Maths should contact the math department as it varies depending on the exam board)
h. AS level Maths score of B or higher
i. IB HL score of 5 or higher
j. IB SL score of 6 or higher
k. a grade of C or higher in MATH-UA 9 Algebra and Calculus

OR

A passing score on a departmental placement exam

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) – 4 points

Prerequisite:

a. a score of 4 or higher on the AP Calculus AB exam, or
b. a score of 4 or higher on the AP Calculus BC exam, or
c. A level Maths score of B or higher (anyone who took Further Maths should contact the math department as it varies depending on the exam board)
d. IB HL of 6 or higher
e. a grade of C or higher in MATH-UA 121 Calculus I

OR

A passing score on a departmental placement exam

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) – 4 points

Prerequisite:

a. a score of 5 on the AP Calculus BC exam
b. a grade of C or higher in MATH-UA 122 Calculus II

OR

A passing score on a departmental placement exam

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 130 Set Theory- 4 points (*Identical to PHIL-UA 73)*

The axioms of set theory; Boolean operations on sets; set-theoretic representation of relations, functions, and orderings; the natural numbers; theory of transfinite cardinal

and ordinal numbers; the axiom of choice and its equivalents; and the foundations of analysis. May also cover such advanced topics as large cardinals or independence results.

MATH-UA 140 Linear Algebra (offered each term) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 121 Calculus I or MATH-UA 211 Math for Economics I (for Economics majors) or equivalent.

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 (offered fall term) – 4 points
(*Identical to MATH-GA 2110*) NOTE: *MATH-GA 2110 is offered every semester but called Linear Algebra I in the fall and summer sessions*
Prerequisite:
A grade of B or higher in MATH-UA 325 Analysis I and/or MATH-UA 343 Algebra I or the equivalent.

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 (offered spring term) – 4 points
(Identical to MATH-GA 2120)
Prerequisite:
A grade of C or higher in MATH-UA 141 Honors Linear Algebra I.

Special theory, eigenvalues, and eigenvectors; Jordan canonical forms. Inner product and orthogonality. Self-adjoint mappings, matrix inequalities. Normed linear spaces and linear transformation between them. Positive matrices. Applications.

MATH-UA 144 Introduction to Computer Simulation (offered spring term) – 4 points *(Identical to CSCI-UA 330)*
Prerequisite:
A grade of C or higher in MATH-UA 121 Calculus I or MATH-UA 212 Math for Economics II (for Economics majors) and PHYS-UA 11 General Physics.

In this course, students will learn how to do computer simulations of such phenomena as orbits (Kepler problem and N-body problem), epidemic and endemic disease (including evolution in response to the selective pressure of a malaria), musical stringed instruments (piano, guitar, and violin), and traffic flow in a city (with lights, breakdowns, and gridlock at corners). The simulations are based on mathematical models, numerical

methods, and Matlab programming techniques that will be taught in class. The use of animations (and sound where appropriate) to present the results of simulations will be emphasized.

MATH-UA 211, 212 Mathematics for Economics I and II (offered each term) – 4 points
Prerequisite for MATH-UA 211
The same as for MATH-UA 121 Calculus I.
Prerequisite for MATH-UA 212
A grade of C or higher in MATH-UA 211.

NOTE: Cannot apply both Calculus courses and Math for Economics courses to your major. Economics majors pursuing a double major in mathematics may substitute MATH-UA 211, 212 for the regular calculus sequence and must complete MATH-UA 213 as well.

Elements of calculus and linear algebra with examples and motivation drawn from important topics in economics. Topics 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 (if time permits) dynamic optimization and multivariable integration.

MATH-UA 213 Mathematics for Economics III (offered each term) – 4 points
Prerequisite:
MATH-UA 212 Math for Economics II

Further topics in vector calculus. Vector spaces, matrix analysis. Linear and nonlinear programming with applications to game theory. This course will provide economics students who have taken MATH-UA 211 Mathematics for Economics I and MATH-UA 212 Mathematics for Economics II with the tools to take higher-level mathematics courses.

MATH-UA 221 Honors Calculus I: Accelerated Calculus with Linear Algebra (offered fall term) – 5 points
Prerequisite:

a. A score of 4 or higher on the Advanced Placement Calculus BC AB exam,
b. A level Maths of B or higher, or IB HL of 6 or higher, or
c. MATH-UA 121 Calculus I

This is the first semester of a yearlong course that covers the essential content of Calculus II and III as well as 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.

MATH-UA 222 Honors Calculus I: Accelerated Calculus with Linear Algebra (offered spring term) – 5 points
Prerequisite:
A grade of B or higher in Honors Calculus I (MATH-UA 221).

Second semester of a yearlong sequence that covers the content of Calculus II and III as well as 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) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 325 Analysis I.

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 228 Earth's Atmosphere and Ocean: Fluid Dynamics and Climate – 4 points *(Identical to ENVST-UA 360)*
Prerequisite:
A grade of B- or higher in MATH-UA 121 Calculus I or MATH-UA 212 Math for Economics II (for Economics majors) or equivalent and familiarity with introductory physics (at least at the advanced high school level).

Recommended and Preferred: MATH-UA 123 Calculus III

Introduction to dynamical processes that drive the circulation of the atmosphere and ocean, and their interaction. Goal of the lectures is to develop an understanding of the unifying principles of planetary fluid dynamics. Topics include the global energy balance, convection and radiation (the greenhouse effect), effects of planetary rotation (the Coriolis force), structure of the atmospheric circulation (the Hadley cell and wind patterns), structure of the oceanic circulation (wind-driven currents and the thermohaline circulation), and climate and climate variability (including El Niño and anthropogenic warming).

MATH-UA 230 Introduction to Fluid Dynamics (offered spring term) – 4 points
(Identical to PHYS-UA 180)
Prerequisite:
A grade of C or higher in MATH-UA 123 Calculus III or MATH-UA 213 Math for Economics III (for Economics majors)
Suggested:
PHYS-UA 106 Mathematical Physics

Fluid dynamics is the branch of physics that describes motions of fluids as varied as the flow of blood in the human body, the flight of an insect or the motions of weather systems on Earth. The course introduces the key concepts of fluid dynamics: the formalism of continuum mechanics, the conservation of mass, energy and momentum in a fluid, the Euler and Navier-Stokes equations, viscosity and vorticity. These concepts are applied to study classic problems in fluid dynamics, such as potential flow around a cylinder, the Stokes flow, the propagation of sound and gravity waves and the onset of instability in shear flow.

MATH-UA 233 Theory of Probability (offered each term) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 123 Calculus III or MATH-UA 213 Math for Economics III (for Economics majors) or equivalent.

NOTE: Not open to students who have taken MATH-UA 235 Probability and Statistics.

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) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 233 Theory of Probability or equivalent.

NOTE: Not open to students who have taken MATH-UA 235.

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) – 4 points
Prerequisite:

A grade of C or higher in MATH-UA 122 Calculus II or MATH-UA 212 Math for Economics II (for Economics majors) or equivalent.

NOTE: Not open to students who have taken MATH-UA 233

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) – 4 points
Prerequisite:
A grade of C or higherMATH-UA 122 Calculus II or MATH-UA 212 Math for Economics II (for Economics majors) or equivalent.

Techniques for counting and enumeration including generating functions, the principle of inclusion and exclusion, and Polyacounting. Graph theory. Modern algorithms and data structures for graph-theoretic problems.

MATH-UA 246 Abstract Algebra (offered spring term) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 122 Calculus II or MATH-UA 212 Math for Economics II (for Economics majors) and MATH-UA 140 Linear Algebra.

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.

NOTE: Although not acceptable for the mathematics majors, it is accepted toward the mathematics minor and is a strongly recommended course for the Steinhardt mathematics education major.
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MATH-UA 248 Theory of Numbers (offered fall term) – 4 points
Prerequisite:
A grade of C or higher MATH-UA 122 Calculus II or MATH-UA 212 Math for Economics II (for Economics majors) or equivalent.

Divisibility theory and prime numbers. Linear and quadratic congruences. The classical number-theoretic functions. Continued fractions. Diophantine equations.

MATH-UA 250 Mathematics of Finance (offered fall term) – 4 points

Prerequisite:
A grade of C or higher in MATH-UA 123 Calculus III and one of the following: MATH-UA 233 Theory of Probability, MATH-UA 235 Probability and Statistics, ECON-UA 18 Statistics, or ECON-UA 20 Analytical Statistics and/or permission of the instructor.

Introduction to the mathematics of finance. Topics include: Linear programming with application to pricing. Interest rates and present value. Basic probability, random walks, central limit theorem, Brownian motion, log-normal 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) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 123 Calculus III or MATH-UA 213 Math for Economics III (for Economics majors) or permission of the instructor.

Formulation and analysis of mathematical models. Mathematical tools include dimensional analysis, optimization, simulation, probability, and elementary differential equations. Applications to biology, economics, and other areas of science. The necessary mathematical and scientific background is developed as needed. Students participate in formulating models as well as in analyzing them.

MATH-UA 252 Numerical Analysis (offered spring term) – 4 points
Prerequisite:
A grade of C or higher in both MATH-UA 123 Calculus III or MATH-UA 213 Math for Economics III (for Economics majors) and MATH-UA 140 Linear Algebra or equivalent.

In numerical analysis, one explores how mathematical problems can be 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 to explore topics ranging from simple root-finding procedures to differential equations and the finite element method.

MATH-UA 255 Mathematics in Medicine and Biology (offered fall term) – 4 points *(Identical to BIOL-GA 1501)*
Prerequisite:
MATH-UA 121 Calculus I or MATH-UA 212 Math for Economics II (for Economics majors) and Principles of BIOL-UA 11 Biology I or permission of the instructor.

Intended primarily for premedical students with interest and ability in mathematics. Topics of medical importance using mathematics as a tool, including 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 (offered spring term) - 4 points *(Identical to BIOL-GA 1502)*
Prerequisite:
A grade of C or higher in MATH-UA 255 Mathematics in Medicine and Biology or permission of the instructor.
Recommendation:
Familiarity with a programming language. The language used in the course will be MATLAB, but prior experience with MATLAB is not required.

Introduces the students of biology or mathematics to the use of the computer as a tool for modeling physiological phenomena. The 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 then uses the models to conduct simulated physiological experiments.

MATH-UA 262 Ordinary Differential Equations (offered each term) – 4 points
Prerequisite:
A grade of C or higher in both MATH-UA 123 Calculus III or MATH-UA 213 Math for Economics III (for Economics majors) and MATH-UA 140 Linear Algebra or equivalent.

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) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 262 Ordinary Differential Equations or equivalent.

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 spring term) – 4 points
Prerequisite:
A grade of C or higher in both MATH-UA 122 Calculus II or MATH-UA 212 Math for Economics II (for Economics majors) and MATH-UA 140 Linear Algebra or equivalent.

Topics include dynamics of maps and of first-order and second-order differential equations: stability, bifurcations, limit cycles, and dissection of systems with fast and slow timescales. Geometric viewpoint, including phase planes, is stressed. Chaotic behavior is introduced in the context of one-variable maps (the logistic), fractal sets, etc.

Applications are drawn from physics and biology. Homework and projects are assigned, as well as a few computer lab sessions. (Programming experience is not a prerequisite.)

MATH-UA 270 Transformations and Geometries (offered fall term) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 123 Calculus III or MATH-UA 213 Math for Economics III (for Economics majors) or equivalent.
Strongly recommended:
MATH-UA 140 Linear Algebra

An axiomatic and algebraic study of Euclidean, non-Euclidean, affine, and projective geometries. Special attention is given to group-theoretic methods.

MATH-UA 282 Functions of Complex Variable (offered spring term) – 4 points
Prerequisite:
A grade of C or higher in both MATH-UA 123 Calculus III or MATH-UA 213 Math for Economics III (for Economics majors) and MATH-UA 140 Linear Algebra or equivalent.

Complex numbers and complex functions. Differentiation and the Cauchy-Riemann equations. Cauchy's theorem and the Cauchy integral formula. Singularities, residues, Taylor and Laurent series. Fractional Linear transformations and conformal mapping. Analytic continuation. Applications to fluid flow etc.

MATH-UA 325 Analysis I (offered each term) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 123 Calculus III or MATH-UA 213 Math for Economics III (for Economics majors) and MATH-UA 140 Linear Algebra or equivalent.

The real number system. Convergence of sequences and series. Rigorous study of functions of one real variable. Continuity, connectedness, compactness, metric spaces.

MATH-UA 326 Analysis II (offered each term) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 325 Analysis I or permission of the department.

Rigorous study of functions of several variables. Limits and continuity. Differentiable functions. The implicit function theorem. Transformation of multiple integrals. Riemann integral.

MATH-UA 343 Algebra I (offered each term) – 4 points
Prerequisite:
A grade of C or higher in both MATH-UA 123 Calculus III or MATH-UA 213 Math for Economics III (for Economics majors) and MATH-UA 140 Linear Algebra or equivalent.
Strongly recommended:

MATH-UA 325 Analysis I

Groups, homomorphisms, automorphisms, permutation groups. Rings, ideals and quotient rings, Euclidean rings, polynomial rings.

MATH-UA 344 Algebra II (offered each term) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 343 Algebra I.

Extension fields, roots of polynomials. Construction with straight-edge and compass. Unique factorization in rings. Elements of Galois theory.

MATH-UA 375 Topology (offered on request) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 325 Analysis I or permission of the department.

Metric spaces, topological spaces, compactness, connectedness. Covering spaces and homotopy groups.

MATH-UA 377 Differential Geometry (offered spring upon request) – 4 points
Prerequisite:
A grade of C or higher in MATH-UA 326 Analysis II or permission of the department.

The differential properties of curves and surfaces. Introduction to differential manifolds and Riemannian geometry.

MATH-UA 393 Honors I (offered fall term) – 4 points
Prerequisite:
Approval of the director of the honors program.

A lecture/seminar course on advanced topics selected by the instructor and the audience, alternating between pure and applied, fall and spring. Topics vary yearly. Detailed course descriptions are available during preregistration

MATH-UA 394 Honors II (offered spring term) – 4 points
Prerequisite:
Approval of the director of the honors program.

The fundamental theorem of algebra, the argument principle; calculus of residues, Fourier transform; the Gamma and Zeta functions, product expansions; Schwarz principle of reflection and Schwarz-Christoffel transformation; elliptic functions, Riemann surfaces; conformal mapping and univalent functions; maximum principle and Schwarz's lemma; the Riemann mapping theorem. Nehari, Conformal Mapping; Ahlfors, Complex Analysis.

MATH-UA 395, 396 Special Topics I–II – 4 points per term
Prerequisite:
Permission of the department.

Topics vary yearly. Detailed course descriptions are available during preregistration. Covers topics not offered regularly, such as experimental courses and courses offered on student demand.

MATH-UA 997, 998 Independent Study – 2 or 4 points per term
Prerequisite:
Permission of the department.

To register for this course, a student must seek out a faculty sponsor and draft a brief research proposal to be approved by the director of undergraduate studies.
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12. Graduate Courses Open to Undergraduates

Qualified students may take courses from the math department in the Graduate School of Arts and Science provided they first obtain permission from the Director of Undergraduate Studies or Vice Chair for Undergraduate Affairs. A few such courses are listed below. 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.

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	Number Theory
MATH-GA 2320	Topology
MATH-GA 2430	Real Variables
MATH-GA 2470	Ordinary Differential Equations
MATH-GA 2701	Methods of Applied Mathematics
MATH-GA 2702	Fluids Dynamics
MATH-GA 2851	Advanced Topics in Math Biology (Mathematical Models of Primitive Organisms)
MATH-GA 2911, 2912	Probability: Limit Theorems I, II
MATH-GA 2350, 2360	Differential Geometry I-II

13. Departmental Faculty

Tim Austin. Assistant Professor. PhD. 2010, University of California, Los Angeles. Research interests: analysis, probability and ergodic theory.

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. 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.

Antoine Cerfon. Assistant Professor of Mathematics. Magnetohydrodynamics in fusion and astrophysical plasmas, nonneutral plasmas, kinetic theory in plasmas and rarefied gases.

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 polytechniqe. Research interests: nonlinear partial differentail, harmonic analysis.

Dimitris Giannakis. Assistant Professor, Ph.D. 2009, University of Chicago. Research interests: Atmosphere ocean science, geometric data analysis, uncertainty quantification.

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.

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

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.

Alexander Hanhart. Clinical Assistant Professor. Ph.D., 2009, University of Minnesota; M.S. 2007, 2002 University of Minnesota, University of Maryland, Baltimore County; B.S. 2000, University of Maryland, Baltimore County. Research interests: Topological and Geometric methods in Mathematical Physics, Scientific Computing.

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.

Chris Jankowski. Clinical Assistant Professor. Ph.D. 2009, University of Pennsylvania. Research interests: Operator Algebras.

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, Zhejing; 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.

Trushant Majmudar. Clinical Assistant Professor. Ph.D. 2006, Duke University. Research interests: Bio-fluid

Dynamics, bio-locomotion, soft condensed matter.

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. 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. Associate 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 (Berkley). Research interests: Large-scale scientific modeling of physical biological, and neurobiological phenomena.

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

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