

MATHEMATICS (BA)

Department Website (<http://math.nyu.edu>)

NYSED: 08307 **HEGIS:** 1701.00 **CIP:** 27.0101

Program Description

The undergraduate division of the Department of Mathematics offers a wide variety of courses in both pure and applied mathematics. Faculty are members of the Courant Institute of Mathematical Sciences, which has become a leading research center through its tradition of integrating mathematical theory and applications.

In addition to the mathematics major, joint programs are available in mathematics and (1) computer science, (2) data science, (3) economics, and (4) engineering. These majors lead to the BA degree in four years, with the exception of the engineering option, which leads to the BS degree from the College of Arts and Science and the BS degree from the NYU Tandon School of Engineering in five years. An accelerated, five-year BA and MS mathematics program is offered with the Graduate School of Arts and Science, as well as an M.A. in mathematics education program with Steinhardt. The department also provides honors programs in (1) mathematics, (2) mathematics and computer science, and (3) economics and mathematics for outstanding students. In addition, independent study courses are available for students with special interests.

Mathematics majors are encouraged to spend a semester studying away. Currently, mathematics courses are offered at NYU Abu Dhabi, NYU London, NYU Paris, and NYU Shanghai.

Honors Program in Mathematics

The honors program is designed for students with a strong commitment to mathematics and is recommended for those who intend to pursue graduate study in this field. The requirements for admission into the honors program are:

1. a GPA of 3.65 or higher in the major (including joint honors requirements),
2. an overall GPA of 3.65 or higher, and
3. approval of the director of the honors program. Interested students should consult with the faculty honors adviser.

Like the regular major, the honors major consists of thirteen 4-credit courses (52 credits). However, students in the honors program must fulfill the requirements of the regular program together with the following additional requirements.

Honors electives: Honors majors must take at least four of the following 4-credit courses:

Course	Title	Credits
MATH-UA 238	Honors Theory of Probability	4
MATH-UA 258	Honors Numerical Analysis	4
MATH-UA 268	Honors Ordinary Differential Equations	4
MATH-UA 328	Honors Analysis I	4
MATH-UA 329	Honors Analysis II	4
MATH-UA 348	Honors Algebra I	4
MATH-UA 349	Honors Algebra II	4
MATH-UA 393		4
MATH-UA 394		4

MATH-UA 397	4
MATH-UA 398	4

Where applicable, the same course counts toward both the advanced electives requirement of the regular major and the honors electives. Students who have taken MATH-UA 325 Analysis or MATH-UA 343 Algebra may not take the corresponding MATH-UA 328 Honors Analysis I or MATH-UA 348 Honors Algebra I to fulfill this requirement.

Honors research project: Honors students must also complete a senior research project and present it at the College's Undergraduate Research Conference in the spring. Students must register for two semesters of independent study (MATH-UA 997 Independent Study, MATH-UA 998) under faculty supervision and obtain approval of their research project from the faculty honors advisor, director of undergraduate studies, or vice chair of undergraduate affairs. The research project can also be completed through the mathematics summer research program (SURE or AM-SURE). Students who participate in the SURE program are required to present their research at the undergraduate research forum at Courant in the fall semester of their senior year.

Joint BS/BS Program in Mathematics and Engineering

The College of Arts and Science, in cooperation with the NYU Tandon School of Engineering, offers a joint BS/BS program in engineering. Students in the program receive the BS degree in mathematics from CAS and the BS degree in either civil, computer, electrical, or mechanical engineering from the Tandon School of Engineering. Further information and advisement are available from the College Advising Center, 726 Broadway, 7th floor; 212-998-8130.

Accelerated BA/MS Program in Mathematics

The College and the Graduate School of Arts and Science offer students the opportunity to obtain both bachelor's and master's degrees in mathematics in five years. Qualifying students are accepted into the program toward the end of the sophomore year or during the junior year before they reach 96 credits. Students must have a minimum 3.50 GPA in order to qualify for acceptance. During their last few undergraduate semesters, students must accelerate by taking one quarter of their graduate courses during regular terms and/or during the summer. Students in the program must satisfy all requirements of both the bachelor's and master's degrees; there is no double-counting of courses. 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 the College Advising Center, 726 Broadway, 7th floor; 212-998-8130.

Departmental Activities and Awards

Mathematics Society

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 as well as attending conferences.

Association for Women in Mathematics (AWM)

The mission and purpose of AWM's NYU chapter is to increase interest in the mathematical sciences and their applications in various industries. It focuses on mentoring, encouraging and bringing together women

undergraduates in mathematics to increase the visibility of women and their contributions in the discipline.

The Society for Industrial and Applied Mathematics (NYU SIAM)

NYU SIAM is open to all undergraduate and graduate students interested in mathematics regardless of major or background. NYU SIAM creates a space for students to come together and discuss topics significant to the learning of mathematics by engaging them with a diverse range of topics and opportunities in math and its related fields; and providing opportunities for mentorship, workshops, and cross-school collaboration.

William Lowell Putnam Competition

The department participates in this annual competition open to all undergraduate mathematics students in the United States and Canada. Interested students should contact the department as early as possible in the school year, as 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)

In this contest, 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 (ICM)

An international contest for high school students and college undergraduates (an extension of the MCM) designed to develop problem-solving skills and 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 students in making the transition to the mathematics major and life at NYU. If interested in becoming a mentor or mentee, please contact the department.

SURE Program

Since the spring 2000 semester, the department has sponsored a number of summer research experiences (SURE) for a selected number of undergraduate math majors. The Summer Undergraduate Research Experience is aimed at mathematics students in their junior year. The project ends with a written report and an oral presentation in the beginning of the fall semester. Funding is 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. Students must have a faculty mentor and research topic to apply.

AM-SURE

A summer research program for undergraduate students interested in applied mathematics, both *modeling* and *simulation*. The main goal is for each student to complete a research project under the joint guidance of graduate students, postdocs, and faculty in the mathematics department at NYU. Some projects will involve theoretical modeling and computer simulation, and others may involve Courant's Applied Math Lab, where students will help conduct experiments to validate models and simulations. The program will include a set of coherent activities such as frequent group academic meetings and social gatherings.

Awards

Departmental awards include the Hollis Cooley Memorial Prize, Mathematics Award, and the Mathematics Award for Academic Achievement.

Admissions

New York University's Office of Undergraduate Admissions supports the application process for all undergraduate programs at NYU. For additional information about undergraduate admissions, including application requirements, see How to Apply (<https://www.nyu.edu/admissions/undergraduate-admissions/how-to-apply.html>).

Program Requirements

Course	Title	Credits
General Education Requirements		
First-Year Seminar		4
EXPOS-UA 1	Writing The Essay:	4
Foreign Language ¹		16
Physical Science		4
Life Science		4
Texts and Ideas		4
Cultures and Contexts		4
Societies and the Social Sciences		4
Expressive Culture		4
Major Requirements		
<i>Foundational Requirements</i>		
MATH-UA 120	Discrete Mathematics	4
MATH-UA 121	Calculus I (or advanced standing credit)	4
MATH-UA 122	Calculus II (or advanced standing credit)	4
MATH-UA 123	Calculus III	4
or MATH-UA 129	Honors Calculus III	
MATH-UA 140	Linear Algebra	4
or MATH-UA 148	Honors Linear Algebra	
<i>Analysis and Algebra Requirements</i>		
MATH-UA 325	Analysis ²	4
or MATH-UA 328	Honors Analysis I	
MATH-UA 343	Algebra	4
or MATH-UA 348	Honors Algebra I	
<i>Advanced Electives Requirement</i>		
Select six additional required courses. The remaining six must include at least three of the following:		24
MATH-UA 233	Theory of Probability	
or MATH-UA 238	Honors Theory of Probability	
MATH-UA 234	Mathematical Statistics	
MATH-UA 240	Combinatorics	
MATH-UA 248	Theory of Numbers	
MATH-UA 252	Numerical Analysis	
or MATH-UA 258	Honors Numerical Analysis	

MATH-UA 253	Linear and Nonlinear Optimization	
MATH-UA 262	Ordinary Diff Equations	
or MATH-UA 268	Honors Ordinary Differential Equations	
MATH-UA 263	Partial Diff Equations	
MATH-UA 264	Chaos & Dynamical Systems	
MATH-UA 282	Functions of a Complex Variable	
MATH-UA 329	Honors Analysis II	
MATH-UA 349	Honors Algebra II	
MATH-UA 375	Topology	
MATH-UA 377	Differential Geometry	
MATH-UA 393		
MATH-UA 394		
MATH-UA 397		
MATH-UA 398		
Electives		
Other Elective Credits		28
Total Credits		128

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The foreign language requirement is satisfied upon successful completion through the Intermediate level of a language. This may be accomplished in fewer than 16 credits, but those credits must then be completed as elective credit.

2

Students are strongly advised to take analysis before algebra.

Study Away

Students majoring and minoring in the Department of Mathematics can spend a semester studying abroad at one of the many academic centers run by NYU Global Programs. Currently, mathematics can be studied at NYU Abu Dhabi, NYU London, NYU Paris, and NYU Shanghai. Students planning study away should make their plans and speak to an adviser early in their NYU careers.

Sample Plan of Study

Course	Title	Credits
1st Semester/Term		
MATH-UA 121	Calculus I	4
MATH-UA 120	Discrete Mathematics	4
Cultures and Contexts		4
First-Year Seminar		4
Credits		16
2nd Semester/Term		
MATH-UA 122	Calculus II ²	4
MATH-UA 140 or MATH-UA 148	Linear Algebra or Honors Linear Algebra	4
Cultures and Contexts		4
EXPOS-UA 1	Writing The Essay:	4
Credits		16
3rd Semester/Term		
MATH-UA 123 or MATH-UA 129	Calculus III or Honors Calculus III	4
Expressive Culture		4
Physical Science		4
Foreign Language I		4
Credits		16

4th Semester/Term		
MATH-UA 325 or MATH-UA 328	Analysis or Honors Analysis I	4
Societies and the Social Sciences		4
Life Science		4
Foreign Language II		4
Credits		16
5th Semester/Term		
MATH-UA 343 or MATH-UA 348	Algebra or Honors Algebra I	4
Advanced Major Elective (#1 of 6) ¹		4
Foreign Language III		4
Other Elective Credits		4
Credits		16
6th Semester/Term		
Advanced Major Elective (#2 of 6)		4
Advanced Major Elective (#3 of 6)		4
Foreign Language IV		4
Other Elective Credits		4
Credits		16
7th Semester/Term		
Advanced Major Elective (#4 of 6)		4
Advanced Major Elective (#5 of 6)		4
Other Elective Credits		4
Other Elective Credits		4
Credits		16
8th Semester/Term		
Advanced Major Elective (#6 of 6)		4
Other Elective Credits		4
Other Elective Credits		4
Other Elective Credits		4
Credits		16
Total Credits		128

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Three of the six must be drawn from a list of specific advanced electives in the program of study; MATH-UA 131, 132, 133, and any course below MATH-UA 120 do not count toward the major.

Recommended Sequence for Majors in Mathematics

For students placing into Calculus I (MATH-UA 121):

- First semester: Calculus I (MATH-UA 121), possibly with Discrete Mathematics (MATH-UA 120)
- Second semester: Calculus II (MATH-UA 122), and Discrete Mathematics if not yet taken
- Third semester: Calculus III (MATH-UA 123) and Linear Algebra or Honors Linear Algebra (MATH-UA 140 or 148)
- Fourth semester: Analysis or Honors Analysis I (MATH-UA 325 or 328)

For students placing into Calculus II (MATH-UA 122):

- First semester: Calculus II (MATH-UA 122) and Discrete Mathematics (MATH-UA 120)
- Second semester: Calculus III or Honors Calculus III (MATH-UA 123 or 129), and Linear Algebra or Honors Linear Algebra (MATH-UA 140 or 148)
- Third semester: Analysis or Honors Analysis I (MATH-UA 325 or 328)

For students placing into Calculus III (MATH-UA 123):

- First semester: Calculus III or Honors Calculus III (MATH-UA 123 or 129), possibly with Discrete Mathematics (MATH-UA 120)
- Second semester: Linear Algebra or Honors Linear Algebra (MATH-UA 140 or 148), and Discrete Mathematics (MATH-UA 120) if not yet taken
- Third semester: Analysis or Honors Analysis I (MATH-UA 325 or 328)

Learning Outcomes

Upon completion of program requirements, students are expected to have acquired:

1. Proficiency in the foundations of modern mathematics, including discrete mathematics, calculus, analysis, and algebra.
2. The ability to communicate mathematically, including understanding, developing, and critiquing mathematical arguments and rigorous proofs.
3. The ability to apply mathematical ideas and methods to questions and problems both within and outside of the mathematical sciences.
4. Advanced knowledge in some specific areas of mathematics, such as differential equations, geometry and topology, complex analysis, probability and statistics, number theory, or numerical analysis.
5. Experience in using appropriate technology to calculate, visualize, and model problems.

Policies

Major Policies

1. MATH-UA 131 Mathematics for Economics I, MATH-UA 132 Mathematics for Economics II, MATH-UA 133 Mathematics for Economics III, formerly MATH-UA 211, MATH-UA 212, MATH-UA 213, do not count toward the major in mathematics as substitutions for the MATH-UA 121 Calculus I, MATH-UA 122 Calculus II, MATH-UA 123 Calculus III sequence. Exceptions may be made for students who have already taken Mathematics for Economics for their declared or intended second or joint major in economics; they must seek the approval of the Department of Mathematics for this substitution. All other students must follow the regular calculus sequence. Students may not register simultaneously for separate courses within the two sequences.
2. Up to two computer science courses at the level of CSCI-UA 101 Intro to Computer Science or higher, or up to two graduate data science (DS-GA) courses, may be counted toward the thirteen courses required for the major. The prerequisites for DS-GA courses are MATH-UA 123 Calculus III, MATH-UA 140 Linear Algebra, and programming experience in Python (preferred) or MATLAB. Probability is a recommended prerequisite.
3. Students who complete the prehealth program may substitute at most two MATH-UA courses by any two of the following: PHYS-UA 11 General Physics I, PHYS-UA 12 General Physics II or PHYS-UA 91 Physics I, PHYS-UA 93 Physics II.
4. However, if these physics courses are used towards the mathematics major, the computer science or data science courses above will not apply towards the major, and vice-versa.
5. Students may double-count no more than two courses toward both the mathematics major and the requirements of another major or minor
6. Courses taken under the Pass/Fail option cannot count toward the major. A grade of C or higher is required in all courses used to

fulfill major requirements. In addition, majors must maintain a 2.0 mathematics GPA.

7. Students may petition to enroll in graduate mathematics courses and apply them to the undergraduate major. Permission is not granted until the student has completed MATH-UA 325 Analysis and the available undergraduate course(s) on the same topic. Please see the undergraduate section of the department's website for more information and to request permission to enroll in a graduate course.
8. All mathematics majors and minors are required to see an undergraduate faculty adviser to review their course of study and be advised on appropriate courses for each term. Inquire at the department office, Warren Weaver Hall, 251 Mercer Street, Room 625 or 627, or call 212-998-3005 for more information.

CAS Mathematics Requirement (Quantitative Reasoning)

1. *Please note that all SAT Subject Examinations are discontinued as of January 2021 in the U.S. and after June 2021 internationally. SAT Subject Examinations are no longer used for Math placement purposes.*
2. To satisfy the College Core Curriculum requirement in Quantitative Reasoning (QR), all College of Arts and Science students must either take one semester of an approved course with mathematical content, or present qualifying advanced standing credit to exempt from the requirement. (There is no CAS examination to exempt students from QR.)
3. Advanced Placement (AP), International Baccalaureate (IB; HL only), and Advanced Level (A Level; not AS) credit in calculus, statistics, and mathematics satisfies the QR requirement, as does similar credit in selected international examinations. Consult the admission section of this Bulletin or a CAS adviser for details on which approved examinations and minimum scores confer credit.
4. Students in the following majors or tracks of study are required to take courses which also satisfy the Core QR requirement: computer science, data science, economics, engineering, global public health, international relations, mathematics, the natural sciences, the prehealth track, psychology, and sociology. (These areas of study differ in whether and how they accept advanced standing credit toward their quantitative requirements; consult the appropriate sections of this Bulletin.)
5. CAS students who are not pursuing one of these courses of study, and who cannot present advanced standing credit for exemption from the QR requirement, must take one of the Quantitative Reasoning (CORE-UA 1XX) courses offered in the College Core Curriculum.
6. Alternatively, students who meet the prerequisites or take a placement exam may register for an appropriate calculus course at the level of Calculus I (MATH-UA 121) or above. Other CAS courses that satisfy the QR requirement (in statistics, e.g.) are posted on the Core Curriculum website, core.cas.nyu.edu.

Placement into Calculus and other Foundational Courses

1. *Please note that all SAT Subject Examinations are discontinued as of January 2021 in the U.S. and after June 2021 internationally. SAT Subject Examinations are no longer used for Math placement purposes.*
2. Students meeting any of the following criteria may enter Calculus I (MATH-UA 121) or Mathematics for Economics I (MATH-UA 131; formerly MATH-UA 211). In addition, students meeting any of the following criteria may register for Discrete Mathematics (MATH-

UA 120), Linear Algebra (MATH-UA 140), or Honors Linear Algebra (MATH-UA 148), although in the case of MATH-UA 148 the required grade in Algebra, Trigonometry, and Functions (MATH-UA 9; formerly Algebra and Calculus) is an A- and not a C.

- SAT general test Mathematics score of 670 or higher (for SAT taken in and after March 2016)
- ACT Mathematics score of 30 or higher
- Advanced Placement (AP) Calculus AB exam score of 3 or higher (must be 4 or 5 to earn credit)
- AB subscore on the AP Calculus BC exam of 3 or higher (must be 4 or 5 to earn credit)
- AP Calculus BC exam score of 3 or higher (must be 4 or 5 to earn credit)
- A Level Mathematics score of C or higher (must be B or higher to earn credit; anyone who took Further Mathematics should consult the mathematics department for placement)
- AS Level Mathematics score of B or higher (no credit is awarded for AS exams)
- International Baccalaureate (IB) HL Mathematics score of 5 or higher (must be 6 or higher to earn credit)
- IB Analysis and Approaches HL score of 5 or higher (must be 6 or higher to earn credit)
- IB Applications and Interpretations HL score of 5 or higher (must be 6 or higher to earn credit)
- IB Analysis and Approaches SL score of 7 (no credit is awarded for SL exams)
- Algebra, Trigonometry, and Functions (MATH-UA 9; formerly Algebra and Calculus) with a grade of C or higher (A-minus or higher for entry into MATH-UA 148), or equivalent
- Passing score on the departmental calculus placement exam
- Students who do not meet any of these prerequisites must take Algebra, Trigonometry, and Functions (MATH-UA 9; formerly Algebra and Calculus) and meet the minimum grade requirement before proceeding to any of the courses listed above.

Advanced Placement with Credit

- Freshmen seeking advanced placement in the mathematics major or minor may present results of the Advanced Placement (AP) Calculus AB or BC Examination.
- A student who earns a 4 or 5 on the Calculus AB exam (or AB subscore) or a 4 on the Calculus BC exam will receive 4 credits equivalent to Calculus I (MATH-UA 121) and will be placed into Calculus II (MATH-UA 122).
- A student who earns a score of 5 on the Calculus BC exam will receive 8 credits, equivalent to both Calculus I (MATH-UA 121) and Calculus II (MATH-UA 122), and will be placed into Calculus III (MATH-UA 123) or Honors Calculus III (MATH-UA 129).
- For calculus equivalencies and placement for advanced standing credit in mathematics from International Baccalaureate (HL only), A Level, and other approved international examinations, please consult the admission section of this Bulletin or a CAS adviser.
- Note that AP and other advanced standing credit by exam **cannot** be used to place into, or ahead in, the Mathematics for Economics I, II, III sequence (MATH-UA 131, 132, 133; formerly 211, 212, 213). These exam credits are not equivalent to any course in this sequence.

Advanced Placement without Credit

- The department periodically gives its own advanced placement exams for students who know the material covered in Calculus I (MATH-UA 121), Calculus II (MATH-UA 122), Mathematics for Economics I (MATH-UA 131; formerly MATH-UA 211), and/or Mathematics for Economics II (MATH-UA 132; formerly MATH-UA 212) and who wish to enter Calculus II (MATH-UA 122), Calculus III (MATH-UA 123), Mathematics for Economics II (MATH-UA 132; formerly MATH-UA 212), or Mathematics for Economics III (MATH-UA 133; formerly MATH-UA 213). There is also an examination to pass out of Calculus III (MATH-UA 123). If a student passes any of these exams, he or she is placed into the next course of the sequence; however, no college credit is given for the courses that are skipped.

NYU Policies

University-wide policies can be found on the New York University Policy pages (<https://bulletins.nyu.edu/nyu/policies/>).

College of Arts and Science Policies

A full list of relevant academic policies can be found on the CAS Academic Policies page (<https://bulletins.nyu.edu/undergraduate/arts-science/academic-policies/>).