The major in mathematics is an introduction to some of the highlights of the development of theoretical mathematics over the past four hundred years from a modern perspective. This study is also applied to many problems, both internal to mathematics and arising in other disciplines such as physics, cryptography, and finance.

Majors begin by taking either Honors mathematics or the calculus sequence. Students who do not take MATH UN1207 HONORS MATHEMATICS A and MATH UN1208 HONORS MATHEMATICS B normally take MATH UN2010 LINEAR ALGEBRA in the second year. Following this, majors begin to learn some aspects of the main branches of modern mathematics: algebra, analysis, and geometry; as well as some of their subdivisions and hybrids (e.g., number theory, differential geometry, and complex analysis). As the courses become more advanced, they also become more theoretical and proof-oriented and less computational.

Aside from the courses offered by the Mathematics Department, cognate courses in areas such as astronomy, chemistry, physics, probability, logic, economics, and computer science can be used toward the major. A cognate course must be a 2000-level (or higher) course and must be approved by the director of undergraduate studies. In general, a course not taught by the Mathematics Department is a cognate course for the mathematics major if either (a) it has at least two semesters of calculus as a stated prerequisite, or (b) the subject matter in the course is mathematics beyond an elementary level, such as PHIL UN3411 SYMBOLIC LOGIC, in the Philosophy Department, or COMS W3203 DISCRETE MATHEMATICS, in the Computer Science Department.

Another requirement for majors is participation in an undergraduate seminar, usually in the junior or senior year. Applied math majors must take the undergraduate seminar in both the junior and senior year. In these seminars, students gain experience in learning an advanced topic and lecturing on it. In order to be eligible for departmental honors, majors must write a senior thesis.

Courses for First-Year Students

The systematic study of mathematics begins with one of the following three alternative calculus and linear algebra sequences:

<table>
<thead>
<tr>
<th>MATH UN1101</th>
<th>MATH UN1102</th>
<th>MATH UN1201</th>
<th>MATH UN1202</th>
<th>MATH UN2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALCULUS I</td>
<td>and CALCULUS II</td>
<td>and CALCULUS III</td>
<td>and CALCULUS IV</td>
<td>and LINEAR ALGEBRA</td>
</tr>
</tbody>
</table>

OR

<table>
<thead>
<tr>
<th>MATH UN1101</th>
<th>MATH UN1102</th>
<th>MATH UN1205</th>
<th>MATH UN2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALCULUS I</td>
<td>and CALCULUS II</td>
<td>and ACCELERATED MULTIVARIABLE</td>
<td>CALC and LINEAR ALGEBRA</td>
</tr>
</tbody>
</table>

Credit is allowed for only one calculus and linear algebra sequence.

Calculus I, II is a standard course in single-variable differential and integral calculus; Calculus III, IV is a standard course in multivariable differential and integral calculus; Accelerated Multivariable Calculus is an accelerated course in multivariable differential and integral calculus.

While Calculus II is no longer a prerequisite for Calculus III, students are strongly urged to take it before taking Calculus III. In particular, students thinking of majoring or concentrating in mathematics or one of the joint majors involving mathematics should take Calculus II before taking Calculus III. Note that Calculus II is a prerequisite for Accelerated Multivariable Calculus, and both Calculus II and Calculus III are prerequisites for Calculus IV.

The third sequence, Honors Mathematics A-B, is for exceptionally well-qualified students who have strong Advanced Placement scores. It covers multivariable calculus (MATH UN1201 CALCULUS III-MATH UN1202 CALCULUS IV) and linear algebra (MATH UN2010 LINEAR ALGEBRA), with an emphasis on theory.

Advanced Placement

The department grants 3 credits for a score of 4 or 5 on the AP Calculus AB exam provided students complete MATH UN1102 CALCULUS II or MATH UN1201 CALCULUS III with a grade of C or better. The department grants 3 credits for a score of 4 on the AP Calculus BC exam provided students complete MATH UN1102 CALCULUS II or MATH UN1201 CALCULUS III with a grade of C or better. The department grants 6 credits for a score of 5 on the AP Calculus BC exam provided students complete MATH UN1201 CALCULUS III or MATH UN1205 ACCELERATED MULTIVARIABLE CALC MATH UN1207 HONORS MATHEMATICS A with a grade of C or better. Students can receive credit for only one calculus sequence.
Placement in the Calculus Sequences

Calculus I
Students who have essentially mastered a precalculus course and those who have a score of 3 or less on an Advanced Placement (AP) exam (either AB or BC) should begin their study of calculus with MATH UN1101 CALCULUS I.

Calculus II and III
Students with a score of 4 or 5 on the AB exam, 4 on the BC exam, or those with no AP score but with a grade of A in a full year of high school calculus may begin with either MATH UN1102 CALCULUS II or MATH UN1201 CALCULUS III. Note that such students who decide to start with Calculus III may still need to take Calculus II since it is a requirement or prerequisite for other courses. In particular, they MUST take Calculus II before going on to MATH UN1202 CALCULUS IV. Students with a score of 5 on the BC exam may begin with Calculus III and do not need to take Calculus II.

Those with a score of 4 or 5 on the AB exam or 4 on the BC exam may receive 3 points of AP credit upon completion of Calculus II with a grade of C or higher. Those students with a score of 5 on the BC exam may receive 6 points of AP credit upon completion of Calculus III with a grade of C or higher.

Accelerated Multivariable Calculus
Students with a score of 5 on the AP BC exam or 7 on the IB HL exam may begin with MATH UN1205 ACCELERATED MULTIVARIABLE CALC. Upon completion of this course with a grade of C or higher, they may receive 6 points of AP credit.

Honors Mathematics A
Students who want a proof-oriented theoretical sequence and have a score of 5 on the BC exam may begin with MATH UN1207 HONORS MATHEMATICS A, which is especially designed for mathematics majors. Upon completion of this course with a grade of C or higher, they may receive 6 points of AP credit.

Transfers Inside the Calculus Sequences
Students who wish to transfer from one calculus course to another are allowed to do so beyond the date specified on the Academic Calendar. They are considered to be adjusting their level, not changing their program. However, students must obtain the approval of the new instructor and their advising dean prior to reporting to the Office of the Registrar.

Grading
No course with a grade of D or lower can count toward the major, interdepartmental major, or concentration. Students who are doing a double major cannot double count courses for their majors.

Senior Thesis and Departmental Honors
In order to be eligible for departmental honors, majors must write a senior thesis. Normally no more than 10% of graduating majors receive departmental honors in a given academic year.

A Senior Thesis in Mathematics is an original presentation of a subject in pure or applied mathematics from sources in the published literature. The thesis must demonstrate significant independent work of the author. A thesis is expected to be between 20 and 50 pages with complete references and must have a substantial expository component to be well received.

A student who is interested in writing a senior thesis needs to identify a faculty member in the Department of Mathematics as an advisor, determine an appropriate topic, and receive the written approval from the faculty advisor and the DUS. The research of the thesis is conducted primarily during the fall term and the final paper is submitted to the DUS by the end of March.

Students must register for MATH UN3994 Senior Thesis in Mathematics I (4 credits) in the fall semester of their senior year. An optional continuation course MATH UN3995 Senior Thesis in Mathematics II (2 credits) is available during the spring. The second term of this sequence may not be taken without the first. Registration for the spring continuation course has no impact on the timeline or outcome of the final paper. Sections of Senior Thesis in Mathematics I and II do NOT count towards the major requirements, with the exception of an advanced written approval by the DUS.

Professors
- David A. Bayer (Barnard)
- Andrew Blumberg
- Simon Brendle
- Ivan Corwin
- Panagiota Daskalopoulos
- Aise Johan de Jong (Department Chair)
- Daniela De Silva (Barnard Chair)
- Julien Dubedat
- Robert Friedman
- Dorian Goldfeld
- Brian Greene
- Richard Hamilton
- Michael Harris
- Ioannis Karatzas
- Mikhail Khovanov
- Alisa Knizel (Barnard)
- Chiu-Chu Liu
- Dusa McDuff (Barnard)
- Andrei Okounkov
- D. H. Phong
- Ovidiu Savin
- Michael Thaddeus
- Eric Urban
- Mu-Tao Wang

Associate Professors
- Amol Aggarwal
- Chao Li
- Lindsay Piechnik (Barnard)
- Will Sawin
Assistant Professors
• Elena Giorgi
• Francesco Lin
• Giulia Sacca

J.F. Ritt Assistant Professors
• Rostislav Akhmechet
• Konstantin Aleshkin
• Amadou Bah
• Shaoyun Bai
• Jeanne Boursier
• Marco Castronovo
• Nathan Chen
• Sam Collingbourne
• Andres Fernandez-Herrero
• Qiao He
• James Hotchkiss
• Yoonjoo Kim
• Gyujin Oh
• Xi Sisi Shen
• Lucy Yang

Senior Lecturers in Discipline
• Lars Nielsen
• Mikhail Smirnov
• Peter Woit

Lecturers in Discipline
• George Dragomir
• Mrudul Thatte

On Leave
• Profs. Aggarwal, Bayer, Corwin, Daskalopoulos, Fernandez-Herrero, Khovanov, Li, Sacca, Sawin, Woit (Fall 2023)
• Profs. Aggarwal, Bayer, Daskalopoulos, Giorgi, Hotchkiss, Khovanov, Li, Thaddeus (Spring 2024)

Major in Mathematics
The major requires 40-42 points as follows:

Select one of the following three calculus and linear algebra sequences (13-15 points including Advanced Placement Credit):

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH UN1101</td>
<td>CALCULUS I</td>
</tr>
<tr>
<td>- MATH UN1102</td>
<td>and CALCULUS II</td>
</tr>
<tr>
<td>- MATH UN1201</td>
<td>and CALCULUS III</td>
</tr>
<tr>
<td>- MATH UN1202</td>
<td>and CALCULUS IV</td>
</tr>
<tr>
<td>- MATH UN2010</td>
<td>and LINEAR ALGEBRA</td>
</tr>
</tbody>
</table>

OR

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH UN1101</td>
<td>CALCULUS I</td>
</tr>
<tr>
<td>- MATH UN1102</td>
<td>and CALCULUS II</td>
</tr>
<tr>
<td>- MATH UN1205</td>
<td>and ACCELERATED MULTIVARIABLE</td>
</tr>
<tr>
<td>- MATH UN2010</td>
<td>CALC</td>
</tr>
<tr>
<td>and LINEAR ALGEBRA</td>
<td></td>
</tr>
</tbody>
</table>

OR

12 points in the following courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH GU4041</td>
<td>INTRO MODERN ALGEBRA I</td>
</tr>
<tr>
<td>MATH GU4042</td>
<td>INTRO MODERN ALGEBRA II</td>
</tr>
<tr>
<td>MATH GU4061</td>
<td>INTRO MODERN ANALYSIS I</td>
</tr>
<tr>
<td>MATH GU4062</td>
<td>INTRO MODERN ANALYSIS II</td>
</tr>
</tbody>
</table>

3 points in the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH UN3951</td>
<td>UNDERGRADUATE SEMINARS I</td>
</tr>
<tr>
<td>or MATH UN3952</td>
<td>UNDERGRADUATE SEMINARS II</td>
</tr>
</tbody>
</table>

12 points from the following:

1) Courses offered by the department numbered 2000 or higher
2) Courses from the list of approved cognate courses below. A maximum of 6 credits may be taken from courses outside the department.

1 UN2015 (Linear Algebra and Probability) does NOT replace UN2010 (Linear Algebra) as prerequisite requirements of math courses. Students will not receive full credit for both courses UN2010 and UN2015.
2 Students who are not contemplating graduate study in mathematics may replace one or both of the two terms of MATH GU4061-MATH GU4062 by one or two of the following courses: MATH UN2500 ANALYSIS AND OPTIMIZATION, MATH UN3007 COMPLEX VARIABLES, MATH UN3028 PARTIAL DIFFERENTIAL EQUATIONS, or MATH GU4032 FOURIER ANALYSIS.
3 Only one Undergraduate Seminar may count towards the major requirements.
4 Additional courses may be selected only with prior written approval from the Director of Undergraduate Studies.

The program of study should be planned with a departmental adviser before the end of the sophomore year. Majors who are planning on graduate studies in mathematics are urged to obtain a reading knowledge of one of the following languages: French, German, or Russian.

Majors are offered the opportunity to write an honors senior thesis under the guidance of a faculty member. Interested students should contact the director of undergraduate studies.
### Major in Applied Mathematics

The major requires 37-41 points as follows:

Select one of the following three calculus and linear algebra sequences (18 points including Advanced Placement Credit):

- **Calculus I**
  - MATH UN1101 and CALCULUS I
  - MATH UN1201 and CALCULUS III
  - MATH UN1202 and CALCULUS IV
  - MATH UN2010 and LINEAR ALGEBRA 1

- **Calculus II**
  - MATH UN1102 and CALCULUS II
  - MATH UN1202 and HONORS MATHEMATICS A
  - MATH UN1203 and HONORS MATHEMATICS B

Select one of the following three courses. The selected course may not count as an elective.

- **MATH UN2500** ANALYSIS AND OPTIMIZATION
- **MATH GU4032** FOURIER ANALYSIS
- **MATH GU4061** INTRO MODERN ANALYSIS I
- **APMA E4901** SEM-PROBLEMS IN APPLIED MATH (junior year)
- **APMA E4903** SEM-PROBLEMS IN APPLIED MATH (senior year)

18 points in electives, with at least 9 points from the following courses.

A maximum of 9 points may be selected from courses outside this list, with prior written approval from the Director of Undergraduate Studies.

- **MATH UN2500** ANALYSIS AND OPTIMIZATION
- **MATH UN2030** ORDINARY DIFFERENTIAL EQUATIONS
- **MATH UN3007** COMPLEX VARIABLES
  - MATH GU4065 or APMA E4204
  - HONORS COMPLEX VARIABLES
- **MATH UN3028** PARTIAL DIFFERENTIAL EQUATIONS
  - APMA E4200 or APMA E6301
  - PARTIAL DIFFERENTIAL EQUATIONS
  - ANALYTIC METHODS FOR PDE'S
- **MATH GU4032** FOURIER ANALYSIS
- **APMA E4300** COMPUT MATH:INTRO-NUMERICAL MATH
- **APMA E4101** APPL MATH III:DYNAMICAL SYSTEMS
- **APMA E4150** APPLIED FUNCTIONAL ANALYSIS
- **APMA E4400** INTRO TO BIOPHYSICAL MODELING
Students will not receive full credit for both courses UN2010 and UN2015.

Major in Computer Science–Mathematics

The goal of this interdepartmental major is to provide substantial background in each of these two disciplines, focusing on some of the parts of each which are closest to the other. Students intending to pursue a Ph.D. program in either discipline are urged to take additional courses, in consultation with their advisers.

The major requires 20 points in computer science, 19-21 points in mathematics, and two 3-point electives in either computer science or mathematics.

Computer Science

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMS W1004</td>
<td>Introduction to Computer Science and Programming in Java</td>
</tr>
<tr>
<td>or COMS W1007</td>
<td>Honors Introduction to Computer Science</td>
</tr>
<tr>
<td>COMS W3134</td>
<td>Data Structures in Java</td>
</tr>
<tr>
<td>or COMS W3137</td>
<td>HONORS DATA STRUCTURES # ALGOL</td>
</tr>
<tr>
<td>COMS W3157</td>
<td>ADVANCED PROGRAMMING</td>
</tr>
<tr>
<td>COMS W3203</td>
<td>DISCRETE MATHEMATICS</td>
</tr>
<tr>
<td>COMS W3261</td>
<td>COMPUTER SCIENCE THEORY</td>
</tr>
<tr>
<td>CSEE W3827</td>
<td>FUNDAMENTALS OF COMPUTER SYSTS</td>
</tr>
</tbody>
</table>

Mathematics

Select one of the following three calculus and linear algebra sequences (13-15 points including Advanced Placement Credit):

- MATH UN1101 - CALCUlus I 
  - MATH UN1102 - and CALCUlus II 
  - MATH UN1201 - and CALCUlus III 
  - MATH UN1202 - and CALCUlus IV 
  - MATH UN2010 - and LINEAR ALGEBRA ¹

OR

- MATH UN1101 - CALCUlus I 
  - MATH UN1102 - and CALCUlus II 
  - MATH UN1205 - and ACCELERATED MULTIVARIABLE 
  - MATH UN2010 - and LINEAR ALGEBRA ¹

OR

- MATH UN1101 - CALCUlus I 
  - MATH UN1102 - and CALCUlus II 
  - MATH UN1207 - and HONORS MATHEMATICS A 
  - MATH UN1208 - and HONORS MATHEMATICS B 
  - MATH UN3951 - UNDERGRADUATE SEMINARS I 
  - or MATH UN3952 - UNDERGRADUATE SEMINARS II 
  - MATH GU4041 - INTRO MODERN ALGEBRA I

¹ UN2015 (Linear Algebra and Probability) does NOT replace UN2010 (Linear Algebra) as prerequisite requirements of math courses. Students will not receive full credit for both courses UN2010 and UN2015.

Major in Economics-Mathematics

For a description of the joint major in economics-mathematics, see the Economics section of this bulletin.

Major in Mathematics-Statistics

The program is designed to prepare the student for: (1) a career in industries such as finance and insurance that require a high level of mathematical sophistication and a substantial knowledge of probability and statistics, and (2) graduate study in quantitative disciplines. Students choose electives in finance, actuarial science, operations research, or other quantitative fields to complement requirements in mathematics, statistics, and computer science.

Mathematics

Select one of the following sequences:

- MATH UN1101 - CALCUlus I 
  - MATH UN1102 - and CALCUlus II 
  - MATH UN1201 - and CALCUlus III 
  - MATH UN1202 - and CALCUlus IV 
  - MATH UN2010 - and LINEAR ALGEBRA ¹

OR

- MATH UN1101 - CALCUlus I 
  - MATH UN1102 - and CALCUlus II 
  - MATH UN1205 - and ACCELERATED MULTIVARIABLE 
  - MATH UN2010 - and LINEAR ALGEBRA ¹

OR

- MATH UN1207 - HONORS MATHEMATICS A 
  - MATH UN1208 - and HONORS MATHEMATICS B 
  - MATH UN2500 - and ANALYSIS AND OPTIMIZATION ¹

Statistics

Introductory Course

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT UN1201</td>
<td>CALC-BASED INTRO TO STATISTICS</td>
</tr>
</tbody>
</table>

Required Courses

- STAT GU4203 - PROBABILITY THEORY
- STAT GU4204 - STATISTICAL INFERENCE
- STAT GU4205 - LINEAR REGRESSION MODELS

Select one of the following courses:

- STAT GU4207 - ELEMENTARY STOCHASTIC PROCESS
- STAT GU4262 - Stochastic Processes for Finance
- STAT GU4264 - STOCHASTIC PROCESSES-APPLICTNS I
- STAT GU4265 - STOCHASTIC METHODS IN FINANCE

Computer Science

Select one of the following courses:

- COMS W1004 - Introduction to Computer Science and Programming in Java
- COMS W1005 - Introduction to Computer Science and Programming in MATLAB

Electives

Select two of the following courses:

- CSOR W4231 - ANALYSIS OF ALGORITHMS I
- COMS W4241 - Numerical Algorithms and Complexity
- MATH BC2006 - COMBINATORICS
- MATH UN2500 - ANALYSIS AND OPTIMIZATION
- MATH UN3007 - COMPLEX VARIABLES
- MATH UN3020 - NUMBER THEORY AND CRYPTOGRAPHY
- MATH UN3386 - DIFFERENTIAL GEOMETRY
- MATH GU4051 - TOPOLOGY
- MATH GU4061 - INTRO MODERN ANALYSIS I
ENGI E1006  INTRO TO COMP FOR ENG/APP SCI
COMS W1007  Honors Introduction to Computer Science

or an advanced computer science offering in programming

Electives
An approved selection of three advanced courses in mathematics, statistics, applied mathematics, industrial engineering and operations research, computer science, or approved mathematical methods courses in a quantitative discipline. At least one elective must be a Mathematics Department course numbered 3000 or above.

1 UN2015 (Linear Algebra and Probability) does NOT replace UN2010 (Linear Algebra) as prerequisite requirements of math courses. Students will not receive full credit for both courses UN2010 and UN2015.

Students interested in modeling applications are recommended to take MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS and MATH UN3028 PARTIAL DIFFERENTIAL EQUATIONS.

Students interested in finance are recommended to take MATH GR5010 INTRO TO THE MATH OF FINANCE, STAT GU4261 STATISTICAL METHODS IN FINANCE, and STAT GU4221 TIME SERIES ANALYSIS.

Students interested in graduate study in mathematics or in statistics are recommended to take MATH GU4061 INTRO MODERN ANALYSIS I and MATH GU4062 INTRO MODERN ANALYSIS II.

Students preparing for a career in actuarial science are encouraged to replace STAT GU4205 LINEAR REGRESSION MODELS with STAT GU4282 Linear Regression and Time Series Methods, and to take among their electives STAT GU4281 Theory of Interest.

Concentration in Mathematics

The concentration requires the following:

Mathematics
Select one of the following three multivariable calculus and linear algebra sequences:

- MATH UN1201 - MATH UN1202 - MATH UN2010
  - CALCULUS III
  - and CALCULUS IV
  - and LINEAR ALGEBRA

OR

- MATH UN1205 - MATH UN2010
  - ACCELERATED MULTIVARIABLE CALC
  - and LINEAR ALGEBRA

OR

- MATH UN1207 - MATH UN1208
  - HONORS MATHEMATICS A
  - and HONORS MATHEMATICS B

Additional Courses
Select at least 12 additional points from any of the courses offered by the department numbered 2000 or higher. A maximum of 3 credits may be taken from courses outside the department.

Any course given by the Mathematics department fulfills the General Studies quantitative reasoning requirement when passed with a satisfactory letter grade.

MATH UN1003 COLLEGE ALGEBRA-ANLYTC GEOMTRY. 3.00 points.
Prerequisites: score of 550 on the mathematics portion of the SAT completed within the last year, or the appropriate grade on the General Studies Mathematics Placement Examination. For students who wish to study calculus but do not know analytic geometry. Algebra review, graphs and functions, polynomial functions, rational functions, conic sections, systems of equations in two variables, exponential and logarithmic functions, trigonometric functions and trigonometric identities, applications of trigonometry, sequences, series, and limits.

Spring 2023: MATH UN1003

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1003</td>
<td>001/12007</td>
<td>M W 11:40am - 12:55pm</td>
<td>Gerhardt Hinkle</td>
<td>3.00</td>
<td>18/30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>407 Mathematics Building</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 1003</td>
<td>002/12008</td>
<td>T Th 6:10pm - 7:25pm</td>
<td>Gerhardt Hinkle</td>
<td>3.00</td>
<td>9/30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>407 Mathematics Building</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fall 2023: MATH UN1003

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1003</td>
<td>001/00080</td>
<td>M W 6:10pm - 7:25pm</td>
<td>Lindsay Piechnik</td>
<td>3.00</td>
<td>44/56</td>
</tr>
<tr>
<td></td>
<td></td>
<td>323 Milbank Hall</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 UN2015 (Linear Algebra and Probability) does NOT replace UN2010 (Linear Algebra) as prerequisite requirements of math courses. Students will not receive full credit for both courses UN2010 and UN2015.

2 For mathematics courses taken in other departments, consult with the director of undergraduate studies.
MATH UN1101 CALCULUS I. 3.00 points.
Prerequisites: (see Courses for First-Year Students). Functions, limits, derivatives, introduction to integrals, or an understanding of pre-calculus will be assumed. (SC)

Spring 2023: MATH UN1101

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1101</td>
<td>001/00020</td>
<td>M W 6:10pm - 7:25pm 3Li002 Milstein Center</td>
<td>Lindsay Piechok</td>
<td>3.00</td>
<td>98/100</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>002/12019</td>
<td>M W 10:10am - 11:25am 402 Chandler</td>
<td>Marco Castronovo</td>
<td>3.00</td>
<td>43/110</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>003/12020</td>
<td>M W 2:40pm - 3:55pm 407 Mathematics Building</td>
<td>Kuan-Wen Chen</td>
<td>3.00</td>
<td>15/30</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>004/12021</td>
<td>T Th 11:40am - 12:55pm 312 Mathematics Building</td>
<td>Rostislav Akhnesht</td>
<td>3.00</td>
<td>58/110</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>005/12022</td>
<td>T Th 2:40pm - 3:55pm 203 Mathematics Building</td>
<td>Luis Fernandez</td>
<td>3.00</td>
<td>43/110</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>006/12023</td>
<td>T Th 4:10pm - 5:25pm 407 Mathematics Building</td>
<td>Chilin Zhang</td>
<td>3.00</td>
<td>5/30</td>
</tr>
</tbody>
</table>

Fall 2023: MATH UN1101

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1101</td>
<td>001/10629</td>
<td>M W 10:10am - 11:25am 614 Schermerhorn Hall</td>
<td>Mridul Thatte</td>
<td>3.00</td>
<td>75/100</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>002/10630</td>
<td>M W 11:40am - 12:55pm 207 Mathematics Building</td>
<td>Nathan Chen</td>
<td>3.00</td>
<td>90/100</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>003/10631</td>
<td>M W 1:10pm - 2:25pm 207 Mathematics Building</td>
<td>Nathan Chen</td>
<td>3.00</td>
<td>91/100</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>004/10632</td>
<td>M W 2:40pm - 3:55pm 312 Mathematics Building</td>
<td>Yin Li</td>
<td>3.00</td>
<td>41/100</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>005/10633</td>
<td>M W 4:10pm - 5:25pm 207 Mathematics Building</td>
<td>Qiao He</td>
<td>3.00</td>
<td>81/100</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>006/10634</td>
<td>M W 6:10pm - 7:25pm 407 Mathematics Building</td>
<td>Kevin Chang</td>
<td>3.00</td>
<td>28/30</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>007/10635</td>
<td>T Th 10:10am - 11:25am 207 Mathematics Building</td>
<td>Qiao He</td>
<td>3.00</td>
<td>78/100</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>008/10636</td>
<td>T Th 11:40am - 12:55pm 207 Mathematics Building</td>
<td>James Hotchkiss</td>
<td>3.00</td>
<td>92/100</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>009/10637</td>
<td>T Th 1:10pm - 2:25pm 142 Uris Hall</td>
<td>James Hotchkiss</td>
<td>3.00</td>
<td>89/100</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>010/10638</td>
<td>T Th 4:10pm - 5:25pm 407 Mathematics Building</td>
<td>Chaim Avram Zeff</td>
<td>3.00</td>
<td>29/30</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>011/10639</td>
<td>T Th 6:10pm - 7:25pm 407 Mathematics Building</td>
<td>Samuel DeHovity</td>
<td>3.00</td>
<td>29/30</td>
</tr>
</tbody>
</table>

MATH UN1102 CALCULUS II. 3.00 points.
Prerequisites: MATH UN1101 or the equivalent. Methods of integration, applications of the integral, Taylor's theorem, infinite series. (SC)

Spring 2023: MATH UN1102

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1102</td>
<td>001/00021</td>
<td>T Th 2:40pm - 3:55pm 304 Barnard Hall</td>
<td>Lindsay Piechok</td>
<td>3.00</td>
<td>99/100</td>
</tr>
<tr>
<td>MATH 1102</td>
<td>002/12024</td>
<td>M W 1:10pm - 2:25pm 407 Mathematics Building</td>
<td>Ryuichi Haney</td>
<td>3.00</td>
<td>11/30</td>
</tr>
<tr>
<td>MATH 1102</td>
<td>003/12025</td>
<td>M W 2:40pm - 3:55pm 417 Mathematics Building</td>
<td>Richard Hamilton</td>
<td>3.00</td>
<td>11/64</td>
</tr>
<tr>
<td>MATH 1102</td>
<td>004/12026</td>
<td>M W 6:10pm - 7:25pm 417 Mathematics Building</td>
<td>Elliott Stein</td>
<td>3.00</td>
<td>46/64</td>
</tr>
<tr>
<td>MATH 1102</td>
<td>005/12027</td>
<td>T Th 10:10am - 11:25am 203 Mathematics Building</td>
<td>Allen Yuan</td>
<td>3.00</td>
<td>43/100</td>
</tr>
<tr>
<td>MATH 1102</td>
<td>006/12028</td>
<td>T Th 11:40am - 12:55pm 203 Mathematics Building</td>
<td>Andres Fernandez Herrera</td>
<td>3.00</td>
<td>15/100</td>
</tr>
<tr>
<td>MATH 1102</td>
<td>007/12029</td>
<td>T Th 6:10pm - 7:25pm 417 Mathematics Building</td>
<td>Patrick Lei</td>
<td>3.00</td>
<td>7/30</td>
</tr>
</tbody>
</table>

Fall 2023: MATH UN1102

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 1102</td>
<td>001/10640</td>
<td>M W 11:00pm - 2:25pm 203 Mathematics Building</td>
<td>Yoonjoo Kim</td>
<td>3.00</td>
<td>77/100</td>
</tr>
<tr>
<td>MATH 1102</td>
<td>002/10641</td>
<td>M W 2:40pm - 3:55pm 203 Mathematics Building</td>
<td>Yoonjoo Kim</td>
<td>3.00</td>
<td>63/100</td>
</tr>
<tr>
<td>MATH 1102</td>
<td>003/10642</td>
<td>M W 4:10pm - 5:25pm 417 Mathematics Building</td>
<td>Lucy Yang</td>
<td>3.00</td>
<td>38/64</td>
</tr>
<tr>
<td>MATH 1102</td>
<td>004/10643</td>
<td>T Th 10:10am - 11:25am 407 Mathematics Building</td>
<td>Nicolas Vilches Reyes</td>
<td>3.00</td>
<td>29/30</td>
</tr>
<tr>
<td>MATH 1102</td>
<td>005/10644</td>
<td>T Th 2:40pm - 3:55pm 407 Mathematics Building</td>
<td>Caleb Ji</td>
<td>3.00</td>
<td>18/30</td>
</tr>
<tr>
<td>MATH 1102</td>
<td>006/10645</td>
<td>T Th 6:10pm - 7:25pm 417 Mathematics Building</td>
<td>Elliott Stein</td>
<td>3.00</td>
<td>46/64</td>
</tr>
</tbody>
</table>
MATH UN1201 CALCULUS III. 3.00 points.
Prerequisites: MATH UN1101 or the equivalent
Prerequisites: MATH UN1101 or the equivalent Vectors in dimensions 2 and 3, complex numbers and the complex exponential function with applications to differential equations, Cramers rule, vector-valued functions of one variable, scalar-valued functions of several variables, partial derivatives, gradients, surfaces, optimization, the method of Lagrange multipliers. (SC)

MATH UN1202 CALCULUS IV. 3.00 points.
Prerequisites: MATH UN1102 and MATH UN1201 or the equivalent
Prerequisites: MATH UN1102 and MATH UN1201 or the equivalent
Multiple integrals, Taylor’s formula in several variables, line and surface integrals, calculus of vector fields, Fourier series. (SC)

MATH UN1205 ACCELERATED MULTIVARIABLE CALC. 4.00 points.
Prerequisites: (MATH UN1101 and MATH UN1102) Vectors in dimensions 2 and 3, vector-valued functions of one variable, scalar-valued functions of several variables, partial derivatives, gradients, optimization, Lagrange multipliers, double and triple integrals, line and surface integrals, vector calculus. This course is an accelerated version of MATH UN1201 - MATH UN1202. Students taking this course may not receive credit for MATH UN1201 and MATH UN1202

MATH UN1207 HONORS MATHEMATICS A. 4.00 points.
Prerequisites: (see Courses for First-Year Students). The second term of this course may not be taken without the first. Multivariable calculus and linear algebra from a rigorous point of view. Recommended for mathematics majors. Fulfills the linear algebra requirement for the major. (SC)

MATH UN1208 HONORS MATHEMATICS B. 4.00 points.
Prerequisites: (see Courses for First-Year Students). The second term of this course may not be taken without the first. Multivariable calculus and linear algebra from a rigorous point of view. Recommended for mathematics majors. Fulfills the linear algebra requirement for the major. (SC)
MATH UN2000 INTRO TO HIGHER MATHEMATICS. 3.00 points.
Introduction to understanding and writing mathematical proofs. Emphasis on precise thinking and the presentation of mathematical results, both in oral and in written form. Intended for students who are considering majoring in mathematics but wish additional training. CC/GS: Partial Fulfillment of Science Requirement. BC: Fulfillment of General Education Requirement: Quantitative and Deductive Reasoning (QUA)

Spring 2023: MATH UN2000
Course Number: MATH 2000
Section/Call Number: 001/12495
Times/Location: T Th 1:10pm - 2:25pm 520 Mathematics Building
Instructor: Francesco Lin
Points: 3.00
Enrollment: 24/50

Fall 2023: MATH UN2000
Course Number: MATH 2000
Section/Call Number: 001/00084
Times/Location: M W 10:10am - 11:25am Ll104 Diana Center
Instructor: Dusa McDuff
Points: 3.00
Enrollment: 29/55

MATH UN2005 INTRODUCTION TO MATHEMATICS PROOFS. 0.00 points.
This is a seminar course that covers the basics of mathematical proofs and in particular the epsilon-delta argument in single variable calculus. Students who have little experience with mathematical proofs are strongly encouraged to take this course concurrently with Honors Math, Into to Modern Algebra, or Intro to Modern Analysis

Spring 2023: MATH UN2005
Course Number: MATH 2005
Section/Call Number: 001/19598
Times/Location: F 11:00am - 1:00pm 622 Mathematics Building
Instructor: Mu-Tao Wang
Points: 0.00
Enrollment: 4/20

Fall 2023: MATH UN2005
Course Number: MATH 2005
Section/Call Number: 001/10961
Times/Location: F 11:00am - 1:00pm 417 Mathematics Building
Instructor: Mu-Tao Wang
Points: 0.00
Enrollment: 47/64

MATH BC2006 COMBINATORICS. 3.00 points.

Spring 2023: MATH BC2006
Course Number: MATH 2006
Section/Call Number: 001/00024
Times/Location: T Th 10:10am - 11:25am 328 Milbank Hall
Instructor: David Bayer
Points: 3.00
Enrollment: 60/56

MATH UN2010 LINEAR ALGEBRA. 3.00 points.
Matrices, vector spaces, linear transformations, eigenvalues and eigenvectors, canonical forms, applications. (SC)

Spring 2023: MATH UN2010
Course Number: MATH 2010
Section/Call Number: 001/12504
Times/Location: M W 10:10am - 11:25am 203 Mathematics Building
Instructor: Amadou Bah
Points: 3.00
Enrollment: 81/100

MATH 2010 002/12541
M W 11:40am - 12:55pm 203 Mathematics Building
Amadou Bah
3.00 84/100

MATH 2010 003/12543
T Th 1:10pm - 2:25pm 312 Mathematics Building
Jie Jun Morris
3.00 72/100

MATH 2010 004/12546
T Th 4:10pm - 5:25pm 203 Mathematics Building
Konstantin Aleshkin
3.00 56/100

MATH 2010 005/12563
T Th 6:10pm - 7:25pm 203 Mathematics Building
Konstantin Aleshkin
3.00 29/100

Fall 2023: MATH UN2010
Course Number: MATH 2010
Section/Call Number: 001/00085
Times/Location: M W 10:10am - 11:25am 405 Milbank Hall
Cristian Iovanov
3.00 67/90

MATH 2010 002/00086
M W 11:40am - 12:55pm 405 Milbank Hall
Cristian Iovanov
3.00 81/110

MATH 2010 003/10962
M W 2:40pm - 3:55pm 207 Mathematics Building
Siddhi Krishna
3.00 96/110

MATH 2010 004/10963
T Th 8:40am - 9:55am 312 Mathematics Building
Andrew Blumberg
3.00 41/110

MATH 2010 005/10964
T Th 4:10pm - 5:25pm 203 Mathematics Building
Marco Castronovo
3.00 86/110
MATH UN2015 Linear Algebra and Probability. 3.00 points.
Linear algebra with a focus on probability and statistics. The course covers the standard linear algebra topics: systems of linear equations, matrices, determinants, vector spaces, bases, dimension, eigenvalues and eigenvectors, the Spectral Theorem and singular value decompositions. It also teaches applications of linear algebra to probability, statistics and dynamical systems giving a background sufficient for higher level courses in probability and statistics. The topics covered in the probability theory part include conditional probability, discrete and continuous random variables, probability distributions and the limit theorems, as well as Markov chains, curve fitting, regression, and pattern analysis. The course contains applications to life sciences, chemistry, and environmental life sciences. No a priori background in the life sciences is assumed. This course is best suited for students who wish to focus on applications and practical approaches to problem solving. It is recommended to students majoring in engineering, technology, life sciences, social sciences, and economics. Math majors, joint majors, and math concentrators must take MATH UN2010 Linear Algebra, which focuses on linear algebra concepts and foundations that are needed for upper-level math courses. MATH UN2015 (Linear Algebra and Probability) does not replace MATH UN2010 (Linear Algebra) as a prerequisite for upper-level math courses. Students may not receive full credit for both courses MATH UN2010 and MATH UN2015.

Spring 2022: MATH UN2015
Course | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 2015 | 001/12568 | T Th 11:40am - 12:55pm 207 Mathematics Building | George Dragomir | 3.00 | 38/100

Fall 2022: MATH UN2015
Course | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 2015 | 001/10965 | T Th 2:40pm - 3:55pm 312 Mathematics Building | George Dragomir | 3.00 | 93/110

MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS. 3.00 points.
Prerequisites: MATH UN1102 and MATH UN1201 or the equivalent.
Prerequisites: MATH UN1102 and MATH UN1201 or the equivalent.

Spring 2022: MATH UN2030
Course | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 2030 | 001/12573 | T Th 10:10am - 11:25am 312 Mathematics Building | Timothy Large | 3.00 | 75/110

MATH 2030 | 002/12584 | T Th 11:40am - 12:55pm 614 Schermerhorn Hall | Florian Johne | 3.00 | 30/110

Fall 2022: MATH UN2030
Course | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 2030 | 001/10966 | M W 1:10pm - 2:25pm 312 Mathematics Building | Elena Giorgi | 3.00 | 69/100

MATH 2030 | 002/10967 | M W 4:10pm - 5:25pm 312 Mathematics Building | Konstantin Alekshin | 3.00 | 89/100

MATH 2030 | 003/10968 | T Th 6:10pm - 7:25pm 142 Uris Hall | Jeanne Bourier | 3.00 | 13/100

MATH UN2500 ANALYSIS AND OPTIMIZATION. 3.00 points.
Prerequisites: MATH UN1102 and MATH UN1201 or the equivalent and MATH UN2010.
Prerequisites: MATH UN1102 and MATH UN1201 or the equivalent and MATH UN2010.

Spring 2022: MATH UN2500
Course | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 2500 | 001/12587 | M W 1:10pm - 2:25pm 207 Mathematics Building | Julien Dubedat | 3.00 | 20/100

MATH 2500 | 002/12594 | M W 2:40pm - 3:55pm 207 Mathematics Building | Ivan Horozov | 3.00 | 66/100

Fall 2022: MATH UN2500
Course | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 2500 | 001/10969 | T Th 8:40am - 9:55am 203 Mathematics Building | Xi Shen | 3.00 | 32/100

MATH 2500 | 002/10970 | T Th 10:10am - 11:25am 203 Mathematics Building | Xi Shen | 3.00 | 73/100

MATH UN3007 COMPLEX VARIABLES. 3.00 points.
Prerequisites: MATH UN1202 An elementary course in functions of a complex variable.
Prerequisites: MATH UN1202 An elementary course in functions of a complex variable.
Fundamental properties of the complex numbers, differentiability, Cauchy-Riemann equations. Cauchy integral theorem. Taylor and Laurent series, poles, and essential singularities. Residue theorem and conformal mapping. (SC)

Fall 2022: MATH UN3007
Course | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 3007 | 001/10971 | T Th 11:40am - 12:55pm 520 Mathematics Building | Ovidiu Savin | 3.00 | 40/50

MATH UN3020 NUMBER THEORY AND CRYPTOGRAPHY. 3.00 points.
Prerequisites: one year of calculus.
Prerequisites: one year of calculus. Prerequisite: One year of Calculus.
Congruences. Primitive roots. Quadratic residues. Contemporary applications

Spring 2022: MATH UN3020
Course | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 3020 | 001/12598 | M W 10:10am - 11:25am 312 Mathematics Building | Daniele Alessandrini | 3.00 | 78/100

MATH 3020 | 002/12599 | M W 2:40pm - 3:55pm 207 Mathematics Building |Bianca Santoro | 3.00 | 66/100

MATH 3020 | 003/12598 | M W 4:10pm - 5:25pm 312 Mathematics Building | Konstantin Alekshin | 3.00 | 89/100

MATH 3020 | 004/12597 | M W 6:10pm - 7:25pm 142 Uris Hall | Jeanne Bourier | 3.00 | 13/100

MATH UN3025 MAKING, BREAKING CODES. 3.00 points.
Prerequisites: (MATH UN1101 and MATH UN1202) and MATH UN1201 and MATH UN2010.
Prerequisites: (MATH UN1101 and MATH UN1202) and MATH UN1201 and MATH UN2010. A concrete introduction to abstract algebra. Topics in abstract algebra used in cryptography and coding theory.

Fall 2022: MATH UN3025
Course | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 3025 | 001/10972 | T Th 1:10pm - 2:25pm 312 Mathematics Building | Dorian Goldfeld | 3.00 | 86/100

MATH UN3025 MAKING, BREAKING CODES. 3.00 points.
Prerequisites: (MATH UN1101 and MATH UN1202) and MATH UN1201 and MATH UN2010.
Prerequisites: (MATH UN1101 and MATH UN1202) and MATH UN1201 and MATH UN2010. A concrete introduction to abstract algebra. Topics in abstract algebra used in cryptography and coding theory.

Fall 2022: MATH UN3025
Course | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 3025 | 001/10972 | T Th 1:10pm - 2:25pm 312 Mathematics Building | Dorian Goldfeld | 3.00 | 86/100

Applied Mathematics
MATH UN3028 PARTIAL DIFFERENTIAL EQUATIONS. 3.00 points.
Prerequisites: MATH UN3027 and MATH UN2010 or the equivalent
Prerequisites: (MATH UN2010 and MATH UN2030) or the equivalent
Introduction to partial differential equations. First-order equations. Linear second-order equations; separation of variables, solution by series expansions. Boundary value problems

Spring 2023: MATH UN3028
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3028</td>
<td>001/12600</td>
<td>T Th 1:10pm - 2:25pm</td>
<td>Elena Giorgi</td>
<td>3.00</td>
<td>78/110</td>
</tr>
</tbody>
</table>

MATH UN3050 DISCRETE TIME MODELS IN FINANC. 3.00 points.
Prerequisites: (MATH UN1102 and MATH UN1201) or (MATH UN1101 and MATH UN1102 and MATH UN1201) and MATH UN2010
Recommended: MATH UN3027 (or MATH UN2030 and SIEO W3600).
Prerequisites: (MATH UN1102 and MATH UN1201) or (MATH UN1101 and MATH UN1102 and MATH UN1201) and MATH UN2010
Recommended: MATH UN3027 (or MATH UN2030 and SIEO W3600).
Elementary discrete time methods for pricing financial instruments, such as options. Notions of arbitrage, risk-neutral valuation, hedging, term-structure of interest rates

Spring 2023: MATH UN3050
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3050</td>
<td>001/12604</td>
<td>M W 6:10pm - 7:25pm</td>
<td>Mikhail</td>
<td>3.00</td>
<td>56/64</td>
</tr>
</tbody>
</table>

MATH UN3386 DIFFERENTIAL GEOMETRY. 3.00 points.
Prerequisites: MATH UN1202 or the equivalent.
Local and global differential geometry of submanifolds of Euclidean 3-space. Frenet formulas for curves. Various types of curvatures for curves and surfaces and their relations. The Gauss-Bonnet theorem

Fall 2023: MATH UN3386
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3386</td>
<td>001/10973</td>
<td>M W 2:40pm - 3:55pm</td>
<td>Richard</td>
<td>3.00</td>
<td>19/50</td>
</tr>
</tbody>
</table>

MATH UN3901 SUPERVISED READINGS I. 1.00-3.00 points.
Prerequisites: The written permission of the faculty member who agrees to act as sponsor (sponsorship limited to full-time instructors on the staff list), as well as the permission of the Director of Undergraduate Studies. The written permission must be deposited with the Director of Undergraduate Studies before registration is completed. Guided reading and study in mathematics. A student who wishes to undertake individual study under this program must present a specific project to a member of the staff and secure his or her willingness to act as sponsor. Written reports and periodic conferences with the instructor. Supervising Readings do NOT count towards major requirements, with the exception of an advanced written approval by the DUS

Fall 2023: MATH UN3901
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3901</td>
<td>001/15172</td>
<td></td>
<td>Peter Woit</td>
<td>1.00-3.00</td>
<td>6/6</td>
</tr>
<tr>
<td>MATH 3901</td>
<td>002/18813</td>
<td></td>
<td>Dusa McDuff</td>
<td>1.00-3.00</td>
<td>3/4</td>
</tr>
<tr>
<td>MATH 3901</td>
<td>003/20896</td>
<td></td>
<td>Nathan Chen</td>
<td>1.00-3.00</td>
<td>4/5</td>
</tr>
<tr>
<td>MATH 3901</td>
<td>004/20897</td>
<td></td>
<td>Aise Johan de Jong</td>
<td>1.00-3.00</td>
<td>1/1</td>
</tr>
<tr>
<td>MATH 3901</td>
<td>005/21101</td>
<td></td>
<td>Armandou Ibah</td>
<td>1.00-3.00</td>
<td>1/1</td>
</tr>
<tr>
<td>MATH 3901</td>
<td>006/21160</td>
<td></td>
<td>Andrew</td>
<td>1.00-3.00</td>
<td>1/1</td>
</tr>
<tr>
<td>MATH 3901</td>
<td>007/21351</td>
<td></td>
<td>Thadeus</td>
<td>1.00-3.00</td>
<td>1/1</td>
</tr>
</tbody>
</table>

MATH UN3902 SUPERVISED READINGS II. 1.00-3.00 points.
Prerequisites: The written permission of the faculty member who agrees to act as sponsor (sponsorship limited to full-time instructors on the staff list), as well as the permission of the Director of Undergraduate Studies. The written permission must be deposited with the Director of Undergraduate Studies before registration is completed. Guided reading and study in mathematics. A student who wishes to undertake individual study under this program must present a specific project to a member of the staff and secure his or her willingness to act as sponsor. Written reports and periodic conferences with the instructor. Supervising Readings do NOT count towards major requirements, with the exception of an advanced written approval by the DUS

Spring 2023: MATH UN3902
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3902</td>
<td>001/17996</td>
<td></td>
<td>Ioannis</td>
<td>1.00-3.00</td>
<td>6/3</td>
</tr>
<tr>
<td>MATH 3902</td>
<td>002/18614</td>
<td></td>
<td>George</td>
<td>1.00-3.00</td>
<td>1/1</td>
</tr>
<tr>
<td>MATH 3902</td>
<td>003/19430</td>
<td></td>
<td>Elena Giorgi</td>
<td>1.00-3.00</td>
<td>1/1</td>
</tr>
<tr>
<td>MATH 3902</td>
<td>004/19825</td>
<td></td>
<td>Siddhi Krishna</td>
<td>1.00-3.00</td>
<td>2/2</td>
</tr>
<tr>
<td>MATH 3902</td>
<td>005/20057</td>
<td></td>
<td>Florian John</td>
<td>1.00-3.00</td>
<td>1/1</td>
</tr>
<tr>
<td>MATH 3902</td>
<td>006/20071</td>
<td></td>
<td>Tudor</td>
<td>1.00-3.00</td>
<td>1/1</td>
</tr>
<tr>
<td>MATH 3902</td>
<td>007/20158</td>
<td></td>
<td>Mikhail</td>
<td>1.00-3.00</td>
<td>2/2</td>
</tr>
<tr>
<td>MATH 3902</td>
<td>008/20194</td>
<td></td>
<td>Khovanov</td>
<td>1.00-3.00</td>
<td>1/1</td>
</tr>
</tbody>
</table>
MATH UN3951 UNDERGRADUATE SEMINARS I. 3.00 points.
Prerequisites: Two years of calculus, at least one year of additional mathematics courses, and the director of undergraduate studies’ permission.
Prerequisites: Two years of calculus, at least one year of additional mathematics courses, and the director of undergraduate studies’ permission. The subject matter is announced at the start of registration and is different in each section. Each student prepares talks to be given to the seminar, under the supervision of a faculty member or senior teaching fellow.

Fall 2023: MATH UN3951

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3951</td>
<td>001/00757</td>
<td>Lindsay</td>
<td>3.00</td>
<td>47/64</td>
<td></td>
</tr>
</tbody>
</table>

MATH UN3952 UNDERGRADUATE SEMINARS II. 3.00 points.
Prerequisites: Two years of calculus, at least one year of additional mathematics courses, and the director of undergraduate studies’ permission.
Prerequisites: Two years of calculus, at least one year of additional mathematics courses, and the director of undergraduate studies’ permission. The subject matter is announced at the start of registration and is different in each section. Each student prepares talks to be given to the seminar, under the supervision of a faculty member or senior teaching fellow. Prerequisite: two years of calculus, at least one year of additional mathematics courses, and the director of undergraduate studies’ permission.

Spring 2023: MATH UN3952

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3952</td>
<td>001/00025</td>
<td>David Bayer</td>
<td>3.00</td>
<td>73/80</td>
<td></td>
</tr>
</tbody>
</table>

MATH UN3994 SENIOR THESIS IN MATHEMATICS I. 4.00 points.
Majors in Mathematics are offered the opportunity to write an honors senior thesis under the guidance of a faculty member. Interested students should contact a faculty member to determine an appropriate topic, and receive written approval from the faculty advisor and the Director of Undergraduate Studies (faculty sponsorship is limited to full-time instructors on the staff list). Research is conducted primarily during the fall term; the final paper is submitted to the Director of Undergraduate Studies during the subsequent spring term. MATH UN3994 SENIOR THESIS IN MATHEMATICS I must be taken in the fall term, during which period the student conducts primary research on the agreed topic.
An optional continuation course MATH UN3995 SENIOR THESIS IN MATHEMATICS II is available during the spring. The second term of this sequence may not be taken without the first. Registration for the spring continuation course has no impact on the timeline or outcome of the final paper. Sections of SENIOR THESIS IN MATHEMATICS I and II do NOT count towards the major requirements, with the exception of an advanced written approval by the DUS.

Fall 2023: MATH UN3994

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3994</td>
<td>001/14137</td>
<td>Peter Woit</td>
<td>4.00</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>MATH 3994</td>
<td>002/15314</td>
<td>Francesco Lin</td>
<td>4.00</td>
<td>3/3</td>
<td></td>
</tr>
<tr>
<td>MATH 3994</td>
<td>003/18563</td>
<td>Guojun Oh</td>
<td>4.00</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>MATH 3994</td>
<td>004/18566</td>
<td>Chiu-Chiu Liu</td>
<td>4.00</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>MATH 3994</td>
<td>005/18567</td>
<td>Ioannis</td>
<td>4.00</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>MATH 3994</td>
<td>006/19060</td>
<td>Karatzas</td>
<td>4.00</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>MATH 3994</td>
<td>007/20733</td>
<td>Mu-Tao Wang</td>
<td>4.00</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>MATH 3994</td>
<td>008/20732</td>
<td>Qiao He</td>
<td>4.00</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>MATH 3994</td>
<td>009/20814</td>
<td>Michael Harris</td>
<td>4.00</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>MATH 3994</td>
<td>010/20924</td>
<td>David Bayer</td>
<td>4.00</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>MATH 3994</td>
<td>011/20970</td>
<td>Dancila De Silva</td>
<td>4.00</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>MATH 3994</td>
<td>012/20971</td>
<td>Eric Urban</td>
<td>4.00</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>MATH 3994</td>
<td>013/21100</td>
<td>Andrew</td>
<td>4.00</td>
<td>1/1</td>
<td></td>
</tr>
</tbody>
</table>

MATH UN3995 SENIOR THESIS IN MATHEMATICS II. 2.00 points.
Majors in Mathematics are offered the opportunity to write an honors senior thesis under the guidance of a faculty member. Interested students should contact a faculty member to determine an appropriate topic, and receive written approval from the faculty advisor and the Director of Undergraduate Studies (faculty sponsorship is limited to full-time instructors on the staff list). Research is conducted primarily during the fall term; the final paper is submitted to the Director of Undergraduate Studies during the subsequent spring term. MATH UN3994 SENIOR THESIS IN MATHEMATICS I must be taken in the fall term, during which period the student conducts primary research on the agreed topic.
An optional continuation course MATH UN3995 SENIOR THESIS IN MATHEMATICS II is available during the spring. The second term of this sequence may not be taken without the first. Registration for the spring continuation course has no impact on the timeline or outcome of the final paper. Sections of SENIOR THESIS IN MATHEMATICS I and II do NOT count towards the major requirements, with the exception of an advanced written approval by the DUS.

Spring 2023: MATH UN3995

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 3995</td>
<td>001/19826</td>
<td>Stephen Miller</td>
<td>2.00</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>MATH 3995</td>
<td>002/19941</td>
<td>Andrew</td>
<td>2.00</td>
<td>1/1</td>
<td></td>
</tr>
<tr>
<td>MATH 3995</td>
<td>003/20039</td>
<td>Dusa McDuff</td>
<td>2.00</td>
<td>1/1</td>
<td></td>
</tr>
</tbody>
</table>
MATH GU4007 ANALYTIC NUMBER THEORY. 3.00 points.
Prerequisites: MATH UN3007
Prerequisites: MATH UN3007 A one semester course covering the theory of modular forms, zeta functions, L -functions, and the Riemann hypothesis. Particular topics covered include the Riemann zeta function, the prime number theorem, Dirichlet characters, Dirichlet L-functions, Siegel zeros, prime number theorem for arithmetic progressions, SL (2, Z) and subgroups, quotients of the upper half-plane and cusps, modular forms, Fourier expansions of modular forms, Hecke operators, L-functions of modular forms.

MATH GU4041 INTRO MODERN ALGEBRA I. 3.00 points.
Prerequisites: MATH UN1102 and MATH UN1202 and MATH UN2010 or the equivalent.
Prerequisites: MATH UN1102 and MATH UN1202 and MATH UN2010 or the equivalent. The second term of this course may not be taken without the first. Groups, homomorphisms, normal subgroups, the isomorphism theorem, symmetric groups, Frobenius groups, Hall subgroups and solvable groups. Characters of the symmetric groups, Sylow theorems, finitely generated abelian groups.

MATH GU4042 INTRO MODERN ALGEBRA II. 3.00 points.
Prerequisites: MATH UN1102 and MATH UN1202 and MATH UN2010 or the equivalent.
Prerequisites: MATH UN1102 and MATH UN1202 and MATH UN2010 or the equivalent. The second term of this course may not be taken without the first. Rings, homomorphisms, ideals, integral and Euclidean domains, the division algorithm, principal ideal and unique factorization domains, fields, algebraic and transcendental extensions, splitting fields, finite fields, Galois theory.

MATH GU4043 ALGEBRAIC NUMBER THEORY. 3.00 points.
Prerequisites: MATH GU4041 and MATH GU4042 or the equivalent.
Prerequisites: MATH GU4041 and MATH GU4042 or the equivalent. Algebraic number fields, unique factorization of ideals in the ring of algebraic integers in the field into prime ideals. Dirichlet unit theorem, numbers and Dedekind zeta function.

MATH GU4044 REPRESENTATIONS OF FINITE GROUPS. 3.00 points.
Prerequisites: MATH UN2010 and MATH GU4041 or the equivalent.
Prerequisites: MATH UN2010 and MATH GU4041 or the equivalent. Finite groups acting on finite sets and finite dimensional vector spaces. Group characters. Relations with subgroups and factor groups. Arithmetic properties of character values. Applications to the theory of finite groups: Frobenius groups, Hall subgroups and solvable groups. Characters of the symmetric groups. Spherical functions on finite groups.

MATH GU4045 ALGEBRAIC CURVES. 3.00 points.
Prerequisites: (MATH GU4041 and MATH GU4042) and MATH UN3007
Prerequisites: (MATH GU4041 and MATH GU4042) and MATH UN3007 Plane curves, affine and projective varieties, singularities, normalization, Riemann surfaces, divisors, linear systems, Riemann-Roch theorem.
MATH GU4051 TOPOLOGY. 3.00 points.
Prerequisites: (MATH UN1202 and MATH UN2010) and rudiments of group theory (e.g., MATH GU4041). MATH UN1208 or MATH GU4061 is recommended, but not required.
Prerequisites: (MATH UN1202 and MATH UN2010) and rudiments of group theory (e.g., MATH GU4041). MATH UN1208 or MATH GU4061 is recommended, but not required. Metric spaces, continuity, compactness, quotient spaces. The fundamental group of topological space. Examples from knot theory and surfaces. Covering spaces.

MATH GU4052 INTRODUCTION TO KNOT THEORY. 3.00 points.
CC/GS: Partial Fulfillment of Science Requirement
Prerequisites: MATH GU4051 Topology and / or MATH GU4061 Introduction To Modern Analysis I (or equivalents). Recommended (can be taken concurrently): MATH UN2010 linear algebra, or equivalent.
Prerequisites: MATH GU4051 Topology and / or MATH GU4061 Introduction To Modern Analysis I (or equivalents). Recommended (can be taken concurrently): MATH UN2010 linear algebra, or equivalent. The study of algebraic and geometric properties of knots in R^3, including but not limited to knot projections and Reidemeisters theorem, Seifert surfaces, braids, tangles, knot polynomials, fundamental group of knot complements. Depending on time and student interest, we will discuss more advanced topics like knot concordance, relationship to 3-manifold topology, other algebraic knot invariants.

MATH GU4053 INTRO TO ALGEBRAIC TOPOLOGY. 3.00 points.
Prerequisites: MATH UN2010 and MATH GU4041 and MATH GU4051
Prerequisites: MATH UN2010 and MATH GU4041 and MATH GU4051
The study of topological spaces from algebraic properties, including the essentials of homology and the fundamental group. The Brouwer fixed point theorem. The homology of surfaces. Covering spaces.

MATH GU4061 INTRO MODERN ANALYSIS I. 3.00 points.
Prerequisites: MATH UN1202 or the equivalent, and MATH UN2010. The second term of this course may not be taken without the first.
Prerequisites: MATH UN1202 or the equivalent, and MATH UN2010. The second term of this course may not be taken without the first. Real numbers, metric spaces, elements of general topology, sequences and series, continuity, differentiation, integration, uniform convergence, Ascoli-Arzelà theorem, Stone-Weierstrass theorem.

MATH GU4062 INTRO MODERN ANALYSIS II. 3.00 points.
Prerequisites: MATH UN1202 or the equivalent, and MATH UN2010. The second term of this course may not be taken without the first.
Prerequisites: MATH UN1202 or the equivalent, and MATH UN2010. The second term of this course may not be taken without the first. Power series, analytic functions, Implicit function theorem, Fabini theorem, change of variables formula, Lebesgue measure and integration, function spaces.

MATH GU4065 HONORS COMPLEX VARIABLES. 3.00 points.
Prerequisites: (MATH UN1207 and MATH UN1208) or MATH GU4061
Prerequisites: (MATH UN1207 and MATH UN1208) or MATH GU4061
A theoretical introduction to analytic functions. Holomorphic functions, harmonic functions, power series, Cauchy-Riemann equations, Cauchy's integral formula, poles, Laurent series, residue theorem. Other topics as time permits: elliptic functions, the gamma and zeta function, the Riemann mapping theorem, Riemann surfaces, Nevanlinna theory.
MATH GU4081 INTRO-DIFFERENTIABLE MANIFOLDS. 3.00 points.
Prerequisites: (MATH GU4051 or MATH GU4061) and MATH UN2010
Prerequisites: (MATH GU4051 or MATH GU4061) and MATH UN2010
Concept of a differentiable manifold. Tangent spaces and vector fields.
The inverse function theorem. Transversality and Sard’s theorem.
forms and Stokes theorem

Spring 2023: MATH GU4081
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
MATH 4081   001/00026  M W 10:10am - 11:25am  207 Milbank Hall  Dusa McDuff   3.00  19/40

MATH GU4155 PROBABILITY THEORY. 3.00 points.
Prerequisites: MATH GU4061 or MATH UN3007
Prerequisites: MATH GU4061 or MATH UN3007 A rigorous introduction
to the concepts and methods of mathematical probability starting with
basic notions and making use of combinatorial and analytic techniques.
Generating functions. Convergence in probability and in distribution.
Discrete probability spaces, recurrence and transience of random walks.
Infinite models, proof of the law of large numbers and the central limit
theorem. Markov chains

Spring 2023: MATH GU4155
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
MATH 4155   001/12633  T Th 1:10pm - 2:25pm  417 Mathematics Building  Ioannis Karatzas   3.00  25/64

MATH GU4156 ADVANCED PROBABILITY THEORY. 3.00 points.
This course will cover advanced topics in probability, including: the theory
of martingales in discrete and in continuous time; Brownian motion and
its properties, stochastic integration, ordinary and partial stochastic
differential equations; Applications to optimal filtering, stopping, control,
and finance; Continuous-time Markov chains, systems of interacting
particles, relative entropy dissipation, notions of information theory;
Electrical networks, random walks on graphs and groups, percolation

Fall 2023: MATH GU4156
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
MATH 4156   001/10984  T Th 2:40pm - 3:55pm  417 Mathematics Building  Ioannis Karatzas   3.00  19/50

MATH GU4391 INTRO TO QUANTUM MECHANICS. 3.00 points.
This course will focus on quantum mechanics, paying attention to
both the underlying mathematical structures as well as their physical
motivations and consequences. It is meant to be accessible to students
with no previous formal training in quantum theory. The role of symmetry,
groups and representations will be stressed

MATH GU4392 INTRO TO QUANTUM MECHANICS II. 3.00 points.
Continuation of GU4391. This course will focus on quantum mechanics,
paying attention to both the underlying mathematical structures as
well as their physical motivations and consequences. It is meant to
be accessible to students with no previous formal training in quantum
theory. The role of symmetry, groups and representations will be stressed.