The Study of Mathematics

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. A list of pre-approved cognate courses can be found under the major requirements.

Another requirement for majors is participation in an undergraduate seminar, usually in the junior or senior year. Applied math majors must take the undergraduate applied math sequence 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.

Student Advising

Director of Undergraduate Studies
Prof. Julien Dubedat, 601 Mathematics; 212-854-8806; jd2653@columbia.edu

Calculus Director

Enrolling in Classes

Most undergraduate level courses in Mathematics can be taken once the prerequisite courses have been completed. Any exceptions to waive a prerequisite requirement must be obtained by writing to the Director of Undergraduate Studies.

Students who wish to register for a section of either Supervised Readings and/or Senior Thesis must first identify a faculty sponsor, determine a suitable topic, and obtain written permission from the Director of Undergraduate Studies. Refer to the Undergraduate Research and Senior Thesis section, below.

Preparing for Graduate Study

Departmental advisors can offer advice about and help with graduate school applications. The Mathematics department also runs a Master's degree program in mathematical finance and a Ph.D. program in mathematics.

Coursework Taken Outside of Columbia

Comprehensive information on college level coursework taken outside Columbia University are described on the College's Academic Regulation website or the General Studies Transfer Credit website.

Advanced Placement

AP or IB calculus may count towards degree requirements, subject to completion of a higher level course:

- 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 CALCU...
CALC or MATH UN1207 HONORS MATHEMATICS A with a grade of C or better.

Students can receive credit for only one calculus sequence. Other college level courses taken during high school may substitute for course prerequisites pending the approval of the Director of Undergraduate Studies, but will not confer credits.

Barnard College Courses
Any course offered by the Mathematics@Barnard department will count towards degree requirements.

Transfer Courses
Courses taken at other colleges or universities prior to matriculation at Columbia may be evaluated for transfer credit. A maximum of 16 transfer credits may be granted.

- Course equivalency requests for any Calculus level course, Linear Algebra, or Ordinary Differential Equations must be submitted to the Calculus Director for evaluation.
- Course equivalency requests for any other mathematics course must be submitted to the Director of Undergraduate Studies for evaluation.

Study Abroad Courses
Although study abroad is not an integral part of your studies in mathematics, it can provide you with exposure to a different culture and a different educational system, and, as such, can be very fulfilling. You may also want to participate in the Budapest Mathematical Seminar or similar programs in your junior year. Keep in mind, however, that study abroad requires careful planning. If you are seriously considering studying abroad, you should consult with the Director of Undergraduate Studies as early in your program as possible in order to plan your major accordingly and to incorporate study abroad courses that are compatible with your major in mathematics.

Summer Courses
Any mathematics or approved cognate course offered during the summer session will count towards the degree, with the exception of online only courses, which do not count towards degree requirements.

Undergraduate Research and Senior Thesis

Undergraduate Research in Courses
MATH UN3901 Supervised Readings I (fall term only)
MATH UN3902 Supervised Readings II (spring term only)

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 Director of Undergraduate Studies.

Senior Thesis Coursework and Requirements
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 Director of Undergraduate Studies. The research of the thesis is conducted primarily during the fall term and the final paper is submitted to the Director of Undergraduate Studies 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, unless prior written approval is obtained from the Director of Undergraduate Studies.

Undergraduate Research Outside of Courses
The department runs several undergraduate research programs aimed at math majors. Opportunities are available during the academic year and summer terms.

The Undergraduate Mathematics Society is the department’s undergraduate club. Detailed information on membership, Society-sponsored seminars and activities, and archival resources are available on the Society’s Web site. The department also sponsors workshops and weekly seminars in mathematics, and posts information about special lectures, conferences, and seminars at nearby schools.

In addition, the Association for Women in Mathematics Columbia Chapter connects students and professors interested in mathematics at Columbia University and Barnard College as part of a broader effort to encourage women and girls to study and to have active careers in the mathematical sciences, and to promote equal opportunity for and the equal treatment of women and girls in the STEM fields.

Department Honors and Prizes

Department Honors
To be recommended to the College Committee on Honors, Awards, and Prizes, which makes the final decisions on all honors’ recipients, you must have a GPA of 3.63 in the major and have completed a senior thesis of merit. For more information on researching and writing the senior thesis and on departmental honors, you should consult with the Director of Undergraduate Studies. Normally no more than 10% of graduating majors receive departmental honors in a given academic year.

Academic Prizes

Putnam Exam
The Putnam exam is a nationwide competitive exam administered each year on the first Saturday in December. A faculty member conducts coaching sessions for students who are interested in competing.
Columbia Prizes
Several prizes for excellence in mathematics are awarded each year to undergraduates, based on performance on a prize exam scheduled each spring. These include:

- **Professor Van Amringe Mathematical Prize**
  - This prize, established in 1910 by George G. Dewitt, Class of 1867, may be awarded to a first year, a sophomore, and a junior student in the College who are deemed most proficient in the mathematical subjects designated during the year of the award.

- **John Dash Van Buren Jr. Prize in Mathematics**
  - Established in 1906 by Mrs. Louis T. Hoyt in memory of her nephew, John Dash Van Buren, Jr., Class of 1905, this prize may be awarded to a Columbia College senior degree candidate who writes the best examination in subjects prescribed by the Mathematics Department.

Other Important Information
Other helpful information may be found on the Department of Mathematics website.

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
- 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
- Francesco Lin
- Lindsay Piechnik (Barnard)

Assistant Professors
- Elena Giorgi
- Giulia Sacca
- Mehtaab Sawhney

J.F. Ritt Assistant Professors
- Rostislav Akhmechet
- Amadou Bah
- Deeparaj Bhat
- Jeanne Boursier
- Marco Castronovo
- Brian Harvie
- Qiao He
- Sven Hirsch
- Andres Ibanez Nunez
- Yoonjoo Kim
- Siddhi Krishna
- Gyujin Oh
- Marco Sangiovanni Vincentelli
- Dawei Shen
- Xi Sisi Shen
- Evan Sorensen
- Roger Van Peski
- Lucy Yang

Senior Lecturers in Discipline
- Mikhail Smirnov
- Peter Woit

Lecturers in Discipline
- George Dragomir

On Leave
- Fall 2024: Profs. Aggarwal, Bayer, Giorgi, Li, Sawhney, Shen, Wang

Guidance for Undergraduate Students in Mathematics

Program Planning for all Students

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.

Transfer 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, minor, or concentration.

Double Counting
Students who are doing a double major should review the College Bulletin’s policy on Double Counting Courses towards Requirements. In general, courses in the Calculus sequence may be counted towards both majors, with up to two additional MATH UN2xxx or higher level courses at the discretion of all approving departments. Students pursuing a minor may double count at most one additional MATH UN2xxx or higher level course.

Course Numbering Structure
• 1000-2000 Level courses are intended to be introductory courses (such as the Calculus sequence and Linear Algebra).
• 3000-4000 Level courses cover more advanced mathematics, as well as supervised readings, undergraduate seminars, and senior theses.
• 5000 Level courses are Master’s level courses.
• 6000 Level and above are PhD level courses.

Guidance 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>CALCULUS I</th>
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<tbody>
<tr>
<td>- MATH UN1102</td>
<td>and CALCULUS II</td>
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<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>
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</tbody>
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OR

<table>
<thead>
<tr>
<th>MATH UN1101</th>
<th>CALCULUS I</th>
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<tbody>
<tr>
<td>- MATH UN1102</td>
<td>and CALCULUS II</td>
</tr>
<tr>
<td>- MATH UN1207</td>
<td>and HONORS MATHEMATICS A</td>
</tr>
<tr>
<td>- MATH UN1209</td>
<td>and HONORS MATHEMATICS B</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.

Guidance for Transfer Students
Consideration for AP, IB and transfer credit is as follows:

Equivalent to MATH UN1101 Calculus I:
• A score of 4 on the Calculus BC Advanced Placement exam.
• A score of 4 or 5 on the Calculus AB Advanced Placement exam.
• A score of 6 on the IB Mathematics: analysis and approaches HL exam (2021 or later) or a score of 6 on the IB HL Mathematics or Further Mathematics exams (2020 or earlier).
• A score of 6 on the IB Mathematics: applications and interpretation HL exam (2021 or later) or a score of 6 on the IB SL Mathematics exam (2020 or earlier). This does not include the IB “Mathematical Studies SL” exam.
• An A on the A-Level Mathematics exam or a B in A-Level Further Mathematics exam in the U.K.
• A grade of A in a full year of high school calculus.

Equivalent to MATH 1101 Calculus I and MATH 1102 Calculus II:
• A score of 5 on the Calculus BC Advanced Placement.
• A score of 7 on the IB Mathematics: analysis and approaches HL exam (2021 or later) or a score of 7 on the IB HL Mathematics or Further Mathematics exams (2020 or earlier).
• An A on the A-Level Further Mathematics exam in the U.K.

Undergraduate Programs of Study
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):

**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

12 points in the following courses:

- MATH GU4041 INTRO MODERN ALGEBRA I
- MATH GU4042 INTRO MODERN ALGEBRA II
- MATH GU4061 INTRO MODERN ANALYSIS I \(^2\)
- MATH GU4062 INTRO MODERN ANALYSIS II \(^2\)

3 points in the following:

- MATH UN3951 UNDERGRADUATE SEMINARS I \(^3\)
- MATH UN3952 UNDERGRADUATE SEMINARS II

12 points from the following:

1) Courses offered by the department numbered 2000 or higher \(^3\)
2) Courses from the list of approved cognate courses below. A maximum of 6 credits may be taken from courses outside the department. \(^4\)

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\(^1\) MATH UN2015 Linear Algebra and Probability does NOT replace MATH 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 refer to the "Undergraduate Research and Senior Thesis" section on the Overview tab for additional information.
The major requires 37-41 points as follows:

1. Take each of the following two required courses:
   - MATH UN1101 and MATH UN1102 (or MATH UN1201 and MATH UN1202, or MATH UN1205 and MATH UN1201, or MATH UN1102 and MATH UN1205, or MATH UN1101 and MATH UN1202, or MATH UN1201 and MATH UN1205, or MATH UN1102 and MATH UN1101, or MATH UN1202 and MATH UN1101, or MATH UN1101 and MATH UN1102, or MATH UN1201 and MATH UN1202, or MATH UN1205 and MATH UN1201, or MATH UN1201 and MATH UN1205, or MATH UN1102 and MATH UN1101, or MATH UN1202 and MATH UN1101, or MATH UN1102 and MATH UN1205, or MATH UN1202 and MATH UN1201, or MATH UN1101 and MATH UN1205, or MATH UN1201 and MATH UN1102, or MATH UN1102 and MATH UN1201, or MATH UN1202 and MATH UN1102, or MATH UN1101 and MATH UN1102, or MATH UN1201 and MATH UN1202, or MATH UN1205 and MATH UN1201, or MATH UN1201 and MATH UN1205, or MATH UN1102 and MATH UN1101, or MATH UN1202 and MATH UN1101, or MATH UN1102 and MATH UN1205, or MATH UN1202 and MATH UN1201, or MATH UN1101 and MATH UN1205, or MATH UN1201 and MATH UN1102, or MATH UN1102 and MATH UN1201, or MATH UN1202 and MATH UN1102, or MATH UN1101 and MATH UN1102, or MATH UN1201 and MATH UN1202, or MATH UN1205 and MATH UN1201, or MATH UN1201 and MATH UN1205, or MATH UN1102 and MATH UN1101, or MATH UN1202 and MATH UN1101, or MATH UN1102 and MATH UN1205, or MATH UN1202 and MATH UN1201, or MATH UN1101 and MATH UN1205, or MATH UN1201 and MATH UN1102, or MATH UN1102 and MATH UN1201, or MATH UN1202 and MATH UN1102, or MATH UN1101 and MATH UN1102, or MATH UN1201 and MATH UN1202, or MATH UN1205 and MATH UN1201, or MATH UN1201 and MATH UN1205, or MATH UN1102 and MATH UN1101, or MATH UN1202 and MATH UN1101, or MATH UN1102 and MATH UN1205, or MATH UN1202 and MATH UN1201, or MATH UN1101 and MATH UN1205, or MATH UN1201 and MATH UN1102, or MATH UN1102 and MATH UN1201, or MATH UN1202 and MATH UN1102, or MATH UN1101 and MATH UN1102, or MATH UN1201 and MATH UN1202, or MATH UN1205 and MATH UN1201, or MATH UN1201 and MATH UN1205, or MATH UN1102 and MATH UN1101, or MATH UN1202 and MATH UN1101, or MATH UN1102 and MATH UN1205, or MATH UN1202 and MATH UN1201, or MATH UN1101 and MATH UN1205, or MATH UN1201 and MATH UN1102, or MATH UN1102 and MATH UN1201, or MATH UN1202 and MATH UN1102, or MATH UN1101 and MATH UN1102, or MATH UN1201 and MATH UN1202, or MATH UN1205 and MATH UN1201, or MATH UN1201 and MATH UN1205, or MATH UN1102 and MATH UN1101, or MATH UN1202 and MATH UN1101, or MATH UN1102 and MATH UN1205, or MATH UN1202 and MATH UN1201, or MATH UN1101 and MATH UN1205, or MATH UN1201 and MATH UN1102, or MATH UN1102 and MATH UN1201, or MATH UN1202 and MATH UN1102, or MATH UN1101 and MATH UN1102, or MATH UN1201 and MATH UN1202, or MATH UN1205 and MATH UN1201, or MATH UN1201 and MATH UN1205, or MATH UN1102 and MATH UN1101, or MATH UN1202 and MATH UN1101, or MATH UN1102 and MATH UN1205, or MATH UN1202 and MATH UN1201, or MATH UN1101 and MATH UN1205, or MATH UN1201 and MATH UN1102, or MATH UN1102 and MATH UN1201, or MATH UN1202 and MATH UN1102, or MATH UN1101 and MATH UN1102, or MATH UN1201 and MATH UN1202, or MATH UN1205 and MATH UN1201, or MATH UN1201 and MATH UN1205, or MATH UN1102 and MATH UN1101, or MATH UN1202 and MATH UN1101, or MATH UN1102 and MATH UN1205, or MATH UN1202 and MATH UN1201, or MATH UN1101 and MATH UN1205, or MATH UN1201 and MATH UN1102, or MATH UN1102 and MATH UN1201, or MATH UN1202 and MATH UN1102, or MATH UN1101 and MATH UN1102, or MATH UN1201 and MATH UN1202, or MATH UN1205 and MATH UN1201, or MATH UN1201 and MATH UN1205, or MATH UN1102 and MATH UN1101, or MATH UN1202 and MATH UN1101, or MATH UN1102 and MATH UN1205, or MATH UN1202 and MATH UN1201, or MATH UN1101 and MATH UN1205,
courses. 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**

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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>COMS W1004</td>
<td>Introduction to Computer Science and Programming in Java</td>
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<tr>
<td>or COMS W1007</td>
<td>Data Structures in Java</td>
</tr>
<tr>
<td>COMS W3134</td>
<td>HONORS DATA STRUCTURES &amp; 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 SYSTEMS</td>
</tr>
</tbody>
</table>

**Mathematics**

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

<table>
<thead>
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<td>CALCULUS I</td>
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<td>- MATH UN1202</td>
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<td>- MATH UN1207</td>
<td>and HONORS MATHEMATICS A</td>
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<td>- MATH UN1208</td>
<td>and HONORS MATHEMATICS B</td>
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<tr>
<td>MATH UN3951</td>
<td>UNDERGRADUATE SEMINARS I</td>
</tr>
<tr>
<td>or MATH UN3952</td>
<td>UNDERGRADUATE SEMINARS II</td>
</tr>
<tr>
<td>MATH GU4041</td>
<td>INTRO MODERN ALGEBRA I</td>
</tr>
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### Electives

Select two of the following courses:

<table>
<thead>
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<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSOR W4231</td>
<td>ANALYSIS OF ALGORITHMS</td>
</tr>
<tr>
<td>COMS W4241</td>
<td>NUMERICAL ALGORITHMS AND COMPLEXITY</td>
</tr>
<tr>
<td>MATH BC2006</td>
<td>COMBINATORICS</td>
</tr>
<tr>
<td>MATH UN2500</td>
<td>ANALYSIS AND OPTIMIZATION</td>
</tr>
<tr>
<td>MATH UN3007</td>
<td>COMPLEX VARIABLES</td>
</tr>
<tr>
<td>MATH UN3020</td>
<td>NUMBER THEORY AND CRYPTOGRAPHY</td>
</tr>
<tr>
<td>MATH UN3386</td>
<td>DIFFERENTIAL GEOMETRY</td>
</tr>
</tbody>
</table>

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### 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.

The major requires 38-43 points as follows:

#### Mathematics

Select one of the following sequences:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</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>
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OR

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
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<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 CALC</td>
</tr>
<tr>
<td>- MATH UN2010</td>
<td>and LINEAR ALGEBRA</td>
</tr>
</tbody>
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OR

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</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 UN1207</td>
<td>and HONORS MATHEMATICS A</td>
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<tr>
<td>- MATH UN1208</td>
<td>and HONORS MATHEMATICS B</td>
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<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>MATH UN3951</td>
<td>UNDERGRADUATE SEMINARS I</td>
</tr>
<tr>
<td>or MATH UN3952</td>
<td>UNDERGRADUATE SEMINARS II</td>
</tr>
<tr>
<td>MATH GU4041</td>
<td>INTRO MODERN ALGEBRA I</td>
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#### Statistics

**Introductory Course**

<table>
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<tr>
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<tbody>
<tr>
<td>STAT UN1201</td>
<td>CALC-BASED INTRO TO STATISTICS</td>
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**Required Courses**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>STAT GU4203</td>
<td>PROBABILITY THEORY</td>
</tr>
<tr>
<td>STAT GU4204</td>
<td>STATISTICAL INFERENCE</td>
</tr>
<tr>
<td>STAT GU4205</td>
<td>LINEAR REGRESSION MODELS</td>
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Select one of the following courses:

<table>
<thead>
<tr>
<th>Course Code</th>
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</tr>
</thead>
<tbody>
<tr>
<td>STAT GU4207</td>
<td>ELEMENTARY STOCHASTIC PROCESS</td>
</tr>
<tr>
<td>STAT GU4262</td>
<td>STOCHASTIC PROCESSES-APPLCATNS</td>
</tr>
<tr>
<td>STAT GU4264</td>
<td>STOCHASTIC PROCESSES-APPLCATNS I</td>
</tr>
<tr>
<td>STAT GU4265</td>
<td>STOCHASTIC METHODS IN FINANCE</td>
</tr>
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</table>

#### Computer Science

Select one of the following courses:

<table>
<thead>
<tr>
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<th>Course Title</th>
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<tbody>
<tr>
<td>MATH GU4051</td>
<td>TOPOLOGY</td>
</tr>
<tr>
<td>MATH GU4061</td>
<td>INTRO MODERN ANALYSIS I</td>
</tr>
</tbody>
</table>

1. MATH UN2015 Linear Algebra and Probability does not replace MATH UN2010 LINEAR ALGEBRA as a prerequisite requirement of math courses. Students will not receive full credit for both courses UN2010 and UN2015.
Minor in Mathematics

The Minor in Mathematics aims to provide students with a solid foundation of mathematical concepts. The program focuses on essential coursework, including multivariable calculus and linear algebra.

The minor functions as a complement to a number of closely related majors, including physics, economics, and computer science. Designed for accessibility, the minor emphasizes foundational understanding rather than proof-based courses, distinguishing it from the comprehensive Mathematics major.

Students in economics, computer science, statistics, physics, and similar natural science programs such as biology and climate science may be particularly interested in the minor. However, its versatile skillset extends beyond these disciplines. Students in language programs, art, and other humanities can also benefit from the minor’s quantitative proficiency, enhancing their studies and future career prospects.

Students start with the minor requirements, e.g. with advanced placement sufficient to start the Multivariable Calculus/Linear Algebra component. Upon completion of the minor, students will have acquired the skills and knowledge to carry out basic and advanced computations, formulate and solve problems, both internal to mathematics and arising from real world applications.

The minor consists of 15-17 points, as follows:

1. Multivariable calculus
2. Linear Algebra
3. Three approved elective courses (at least 9 points), two of which must be 2000+ level courses offered by the Mathematics department. The third course may either be an additional course in Math, or selected from a list of approved cognate courses. Only one Undergraduate Seminar in Mathematics (MATH UN3951 UNDERGRADUATE SEMINARS I or MATH UN3952 UNDERGRADUATE SEMINARS II) may count towards the minor requirements.

Multivariable Calculus & Linear Algebra

Select one of the following five multivariable and linear algebra sequences:

| MATH UN1202 | CALCULUS IV and LINEAR ALGEBRA |
| OR |
| MATH UN1202 | CALCULUS IV and Linear Algebra and Probability |
| OR |
| MATH UN1205 | ACCELERATED MULTIVARIABLE CALC and LINEAR ALGEBRA |
| OR |
| MATH UN1205 | ACCELERATED MULTIVARIABLE CALC and Linear Algebra and Probability |
| OR |
| MATH UN1207 | HONORS MATHEMATICS A and HONORS MATHEMATICS B |

Electives

Select three elective courses (at least 9 points), two of which must be 2000+ level courses offered by the Mathematics department. The third course may either be an additional course in Math, or selected from a list of approved cognate courses. Only one Undergraduate Seminar in Mathematics (MATH UN3951 UNDERGRADUATE SEMINARS I or MATH UN3952 UNDERGRADUATE SEMINARS II) may count towards the minor requirements.

1 See the list of approved cognate courses (p. 6) under the Major in Mathematics

Prerequisites

Prerequisites for the courses in (1) Multivariable calculus and (2) Linear Algebra are as follows:

- MATH UN1202 CALCULUS IV: requires MATH UN1102 CALCULUS II and MATH UN1201 CALCULUS III
- MATH UN1205 ACCELERATED MULTIVARIABLE CALC: requires MATH UN1101 CALCULUS I and MATH UN1102 CALCULUS II
- MATH UN2010 LINEAR ALGEBRA: MATH UN1201 CALCULUS III (strongly recommended)
- MATH UN2015 Linear Algebra and Probability: MATH UN1101 CALCULUS I (strongly recommended)
Minor in Mathematical Probability

Probability Theory is a core mathematical subject with deep connections to a wide variety of disciplines. Many fundamental probabilistic concepts and problems stem from such fruitful interactions, from material sciences (e.g. percolation) to social sciences and computer science (e.g. random networks). The Minor in Mathematical Probability is a focused minor aiming at providing students majoring in these disciplines with a solid mathematical foundation organized around the probabilistic concepts pertinent to their main program of study. The transversal nature of probability both in science at large, and in terms of university structure, is underlined by the option of satisfying some core and elective requirements in other departments, such as Statistics and Industrial Engineering and Operation Research.

The minor naturally complements programs of study in natural and social sciences. As a focused minor, it also provides students with precise guidance on choices of coursework with direct relevance to and synergy with their major.

Students start with the minor requirements, e.g. with advanced placement sufficient to start the Multivariable Calculus/Linear Algebra component. Upon completion of the minor, students will have acquired core mathematical skillsets motivated and illustrated by interactions with other disciplines, organized around theoretical and applied probability. The specialized structure and designation of the minor may also benefit career and professional development.

The minor consists of 15–17 points, as follows:

1. Multivariable calculus
2. Linear Algebra
3. Probability Theory
4. Two approved elective courses (at least 6 points), at least one of which is an approved course offered by the Mathematics Department. The second course may either be an additional course in Math, or selected from the list of approved cognate courses.

Multivariable Calculus & Linear Algebra

<table>
<thead>
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<th>Course Name</th>
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<tbody>
<tr>
<td>MATH UN1201</td>
<td>CALCULUS III</td>
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<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>MATH UN1205</td>
<td>ACCELERATED MULTIVARIABLE CALC</td>
</tr>
<tr>
<td>OR</td>
<td></td>
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<tr>
<td>MATH UN1207</td>
<td>HONORS MATHEMATICS A</td>
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Probability Theory

<table>
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<th>Course Name</th>
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<td>MATH GU155</td>
<td>PROBABILITY THEORY</td>
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<tr>
<td>OR</td>
<td></td>
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<tr>
<td>STAT GU4203</td>
<td>PROBABILITY THEORY</td>
</tr>
<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>IEOR E3658</td>
<td>PROBABILITY THEORY FOR ENGINEERS</td>
</tr>
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</table>

Electives

Select two elective courses (at least 6 points), at least one of which is an approved course offered by the Mathematics Department. The second course may either be an additional course in Math, or selected from the list of approved cognate courses below.

<table>
<thead>
<tr>
<th>Course ID</th>
<th>Course Name</th>
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<tbody>
<tr>
<td>MATH UN1201</td>
<td>CALCULUS III</td>
</tr>
<tr>
<td>OR</td>
<td></td>
</tr>
<tr>
<td>MATH UN2030</td>
<td>ORDINARY DIFFERENTIAL EQUATIONS</td>
</tr>
<tr>
<td>MATH UN2500</td>
<td>ANALYSIS AND OPTIMIZATION</td>
</tr>
<tr>
<td>MATH UN3028</td>
<td>PARTIAL DIFFERENTIAL EQUATIONS</td>
</tr>
<tr>
<td>MATH UN3050</td>
<td>DISCRETE TIME MODELS IN FINANC</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>
<tr>
<td>MATH GU4156</td>
<td>ADVANCED PROBABILITY THEORY</td>
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Approved Cognate Electives

<table>
<thead>
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<th>Course ID</th>
<th>Course Name</th>
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<tbody>
<tr>
<td>COMS W3203</td>
<td>DISCRETE MATHEMATICS</td>
</tr>
<tr>
<td>IEOR E3106</td>
<td>STOCHASTIC SYSTEMS AND APPLICATIONS</td>
</tr>
<tr>
<td>PHIL GU4561</td>
<td>PROBABILITY # DECISION THEORY</td>
</tr>
<tr>
<td>PHYS GU4023</td>
<td>THERMAL # STATISTICAL PHYSICS</td>
</tr>
<tr>
<td>STAT GU204</td>
<td>STATISTICAL INFERENCE</td>
</tr>
<tr>
<td>STAT GU207</td>
<td>ELEMENTARY STOCHASTIC PROCESS</td>
</tr>
<tr>
<td>STAT GU262</td>
<td>Stochastic Processes for Finance</td>
</tr>
<tr>
<td>STAT GU264</td>
<td>STOCHASTIC PROCESSES-APPLICTNS I</td>
</tr>
</tbody>
</table>

Prerequisites

Prerequisites for the courses in (1) Multivariable calculus and (2) Linear Algebra are as follows:

- MATH UN1201 CALCULUS III: requires MATH UN1101 CALCULUS I
- MATH UN1205 ACCELERATED MULTIVARIABLE CALC: requires MATH UN1101 CALCULUS I and MATH UN1102 CALCULUS II
- MATH UN2010 LINEAR ALGEBRA: MATH UN1201 CALCULUS III (strongly recommended)
- MATH UN2015 Linear Algebra and Probability: MATH UN1101 CALCULUS I (strongly recommended)

Prerequisites for the courses in (3) Probability Theory are as follows:

- MATH GU4155 PROBABILITY THEORY: MATH GU4061 INTRO MODERN ANALYSIS I (approved elective)
- STAT GU203 PROBABILITY THEORY: At least one semester, and preferably two, of calculus. An introductory course (STAT UN1201 CALC-BASED INTRO TO STATISTICS, preferably) is strongly recommended
- IEOR E3658 PROBABILITY FOR ENGINEERS: Solid knowledge of calculus, including multiple variable integration

For students who entered Columbia in or before the 2023-24 academic year

Concentration in Mathematics

The concentration requires the following:

Mathematics

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

- MATH UN1201 CALCULUS III
- MATH UN2010 and CALCULUS IV
- MATH UN2010 and LINEAR ALGEBRA 1

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

<table>
<thead>
<tr>
<th>Course</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
</tr>
</thead>
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<td>001/00326</td>
<td>M W 6:10pm - 7:25pm</td>
<td>Lindsay Piechnik</td>
<td>3.00</td>
<td>95/100</td>
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<tr>
<td>MATH 1101</td>
<td>002/12300</td>
<td>T Th 10:10am - 11:25am</td>
<td>Mruul Thatte</td>
<td>3.00</td>
<td>42/100</td>
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<tr>
<td>MATH 1101</td>
<td>003/12301</td>
<td>T Th 2:40pm - 3:55pm</td>
<td>Alex Xu</td>
<td>3.00</td>
<td>25/30</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>004/12302</td>
<td>T Th 6:10pm - 7:25pm</td>
<td>Amal Mattoo</td>
<td>3.00</td>
<td>16/30</td>
</tr>
<tr>
<td>MATH 1101</td>
<td>005/12303</td>
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<td>48/100</td>
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<tr>
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<td>006/12304</td>
<td>M W 4:10pm - 5:25pm</td>
<td>Jorge Pineiro</td>
<td>3.00</td>
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**Fall 2024: MATH UN1003**

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<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
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<tr>
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<td>M W 11:40am - 12:55pm</td>
<td>Taeseok Lee</td>
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<td>MATH 1003</td>
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<td>MATH 1003</td>
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<td>Marco Castronovo</td>
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<td>Marco Castronovo</td>
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<td>13/100</td>
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<tr>
<td>MATH 1003</td>
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<td>Marco Castronovo</td>
<td>3.00</td>
<td>13/100</td>
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<tr>
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<td>001/00081</td>
<td>T Th 1:10pm - 2:25pm</td>
<td>Lindsay Piechnik</td>
<td>3.00</td>
<td>100/100</td>
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<tr>
<td>MATH 1103</td>
<td>002/00082</td>
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<td>Lindsay Piechnik</td>
<td>3.00</td>
<td>100/100</td>
</tr>
<tr>
<td>MATH 1103</td>
<td>003/11833</td>
<td>M W 10:10am - 11:25am</td>
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<td>MATH 1103</td>
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<td>005/11837</td>
<td>M W 2:40pm - 3:55pm</td>
<td>George Dragomir</td>
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</tr>
<tr>
<td>MATH 1103</td>
<td>006/11838</td>
<td>M W 4:10pm - 5:25pm</td>
<td>O. FACULTY</td>
<td>3.00</td>
<td>8/30</td>
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<td>3.00</td>
<td>7/100</td>
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<tr>
<td>MATH 1103</td>
<td>008/11841</td>
<td>M W 8:10am - 9:25am</td>
<td>Soren Galatius</td>
<td>3.00</td>
<td>9/45</td>
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<tr>
<td>MATH 1103</td>
<td>009/11842</td>
<td>M W 11:40am - 12:55pm</td>
<td>George Dragomir</td>
<td>3.00</td>
<td>22/100</td>
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<tr>
<td>MATH 1103</td>
<td>010/11844</td>
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<td>Marco SangiovanniVincentelli</td>
<td>3.00</td>
<td>2/100</td>
</tr>
<tr>
<td>MATH 1103</td>
<td>011/11845</td>
<td>T Th 6:10pm - 7:25pm</td>
<td>O. FACULTY</td>
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<td>3/30</td>
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<tr>
<td>MATH 1103</td>
<td>012/00857</td>
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<td>O. FACULTY</td>
<td>3.00</td>
<td>11/100</td>
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</table>
MATH UN1102 CALCULUS II. **3.00 points.**
Prerequisites: MATH UN1101 or the equivalent.
Methods of integration, applications of the integral, Taylors theorem, infinite series. (SC)

<table>
<thead>
<tr>
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<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>001/00227</td>
<td>T Th 2:40pm - 3:55pm Li103 Diana Center</td>
<td>Lindsay Piekos</td>
<td>3.00</td>
<td>57/60</td>
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<tr>
<td>MATH 1102</td>
<td>002/12305</td>
<td>T Th 10:10am - 11:25am 407 Mathematics Building</td>
<td>Lucy Yang</td>
<td>3.00</td>
<td>34/100</td>
</tr>
<tr>
<td>MATH 1102</td>
<td>003/12306</td>
<td>T Th 1:10pm - 2:25pm 417 Mathematics Building</td>
<td>Tomasz Owsiak</td>
<td>3.00</td>
<td>61/64</td>
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<tr>
<td>MATH 1102</td>
<td>004/12307</td>
<td>T Th 6:10pm - 7:25pm 520 Mathematics Building</td>
<td>Fan Zhou</td>
<td>3.00</td>
<td>11/30</td>
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<tr>
<td>MATH 1102</td>
<td>005/12308</td>
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<td>Davis Lazowski</td>
<td>3.00</td>
<td>23/30</td>
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<tr>
<td>MATH 1102</td>
<td>006/12309</td>
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**Fall 2024: MATH UN1102**

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<td>MATH 1102</td>
<td>001/11847</td>
<td>M W 1:10pm - 2:25pm 207 Mathematics Building</td>
<td>Andres Ibanez Nunez</td>
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<tr>
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<tr>
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<td>T Th 8:40am - 9:55am 203 Mathematics Building</td>
<td>Lucy Yang</td>
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<tr>
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<td>T Th 10:10am - 11:25am 203 Mathematics Building</td>
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<td>3.00</td>
<td>6/100</td>
</tr>
<tr>
<td>MATH 1102</td>
<td>006/11852</td>
<td>T Th 6:10pm - 7:25pm 417 Mathematics Building</td>
<td>Elliott Stein</td>
<td>3.00</td>
<td>21/64</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, 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)

<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>
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<tbody>
<tr>
<td>MATH 1201</td>
<td>001/00228</td>
<td>M W 10:10am - 11:25am 405 Milbank Hall</td>
<td>Cristian Iovanov</td>
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<tr>
<td>MATH 1201</td>
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<td>M W 11:40am - 12:55pm 323 Milbank Hall</td>
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<td>Ivan Horozov</td>
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<td>Shaojun Bai</td>
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**Fall 2024: MATH UN1201**

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<td>Deeparaj Bhat</td>
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<td>MATH 1201</td>
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<td>Gyujin Oh</td>
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<td>Gyujin Oh</td>
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<td>Yoonjoo Kim</td>
<td>3.00</td>
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<tr>
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<td>T Th 4:10pm - 5:25pm 312 Mathematics Building</td>
<td>Yoonjoo Kim</td>
<td>3.00</td>
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</table>
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)  
Spring 2024: MATH UN1202  
<table>
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<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
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<td>Qiao He</td>
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<td>37/64</td>
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<tr>
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Fall 2024: MATH UN1202  
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<th>Enrollment</th>
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<td>MATH 1202</td>
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<td>Daniela De Silva</td>
<td>3.00</td>
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<td>MATH 1202</td>
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<td>Mikhail Smirnov</td>
<td>3.00</td>
<td>52/100</td>
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MATH UN1205 ACCELERATED MULTIVARIABLE CALC. 4.00 points.  
Prerequisites: (MATH UN1101 and MATH UN1102)  
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  
Spring 2024: MATH UN1205  
<table>
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<th>Course Number</th>
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<tr>
<td>MATH 1205</td>
<td>001/12328</td>
<td>T Th 11:40am - 12:55pm 417 Mathematics Building</td>
<td>Sam Collingbourne</td>
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Fall 2024: MATH UN1205  
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<td>MATH 1205</td>
<td>001/11864</td>
<td>M W 1:10pm - 2:25pm 417 Mathematics Building</td>
<td>Dawei Shen</td>
<td>4.00</td>
<td>23/64</td>
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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)  
Fall 2024: MATH UN1207  
<table>
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<th>Instructor</th>
<th>Points</th>
<th>Enrollment</th>
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<tr>
<td>MATH 1207</td>
<td>001/11865</td>
<td>T Th 11:40am - 12:55pm 417 Mathematics Building</td>
<td>Giulia Sacca</td>
<td>4.00</td>
<td>9/64</td>
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</table>

MATH UN1208 HONORS MATHEMATICS B. 4.00 points.  
Prerequisites: (see Courses for First-Year Students).  
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)  
Spring 2024: MATH UN1208  
<table>
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<tr>
<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
<th>Points</th>
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<tr>
<td>MATH 1208</td>
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<td>T Th 1:10pm - 2:25pm 417 Mathematics Building</td>
<td>George Dragomir</td>
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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 2024: MATH UN2000  
<table>
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<th>Course Number</th>
<th>Section/Call Number</th>
<th>Times/Location</th>
<th>Instructor</th>
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<td>MATH 2000</td>
<td>001/12330</td>
<td>T Th 1:10pm - 2:25pm 520 Mathematics Building</td>
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Fall 2024: MATH UN2000  
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<tr>
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<td>001/00013</td>
<td>M W 10:10am - 11:25am 328 Milbank Hall</td>
<td>Dusa McDuff</td>
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</table>

MATH BC2001 PERSPECTIVES IN MATHEMATICS. 1.00 point.  
Prerequisites: some calculus or the instructor's permission. Intended as an enrichment to the mathematics curriculum of the first years, this course introduces a variety of mathematical topics (such as three dimensional geometry, probability, number theory) that are often not discussed until later, and explains some current applications of mathematics in the sciences, technology and economics  
Spring 2024: MATH BC2001  
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<td>W 1:10pm - 2:00pm LI103 Diana Center</td>
<td>Dusa McDuff</td>
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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 2024: MATH UN2005  
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<th>Times/Location</th>
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<td>F 11:00am - 1:00pm 417 Mathematics Building</td>
<td>Mu-Tao Wang</td>
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Fall 2024: MATH UN2005  
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<th>Times/Location</th>
<th>Instructor</th>
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<th>Enrollment</th>
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<tr>
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<td>F 11:00am - 1:00pm 417 Mathematics Building</td>
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MATHEMATICS-STATISTICS

MATH BC2006 COMBINATORICS. 3.00 points.
MATH UN2010 LINEAR ALGEBRA. 3.00 points.

Spring 2024: MATH BC2006

<table>
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<th>Course Number</th>
<th>Section/Call Number</th>
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<tr>
<td>MATH 2006</td>
<td>001/00254</td>
<td>T Th 10:10am - 11:25am 328 Milbank Hall</td>
<td>Alisa Knizel</td>
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</table>

MATHEMATICS-STATISTICS

MATH BC2006 COMBINATORICS. 3.00 points.
MATH UN2010 LINEAR ALGEBRA. 3.00 points.

Matrices, vector spaces, linear transformations, eigenvalues and eigenvectors, canonical forms, applications. (SC)

Spring 2024: MATH UN2010

<table>
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<th>Course Number</th>
<th>Section/Call Number</th>
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<td>Rostislav Akhmechet</td>
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<tr>
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Fall 2024: MATH UN2010

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<th>Instructor</th>
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<td>M W 11:40am - 12:55pm 405 Milbank Hall</td>
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<td>MATH 2010</td>
<td>003/11867</td>
<td>M W 2:40pm - 3:55pm 142 Uris Hall</td>
<td>Siddhi Krishna</td>
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<td>Amadou Bah</td>
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MATHEMATICS-STATISTICS

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 prior i 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 prerequisite requirements of math courses. Students may not receive full credit for both courses MATH UN2010 and MATH UN2015.

Spring 2024: MATH UN2015

<table>
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<th>Course Number</th>
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<td>Chen-Chih Lai</td>
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Fall 2024: MATH UN2015

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<td>001/11870</td>
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<td>Evan Sorensen</td>
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<td>MATH 2015</td>
<td>002/11871</td>
<td>T Th 1:10pm - 2:25pm 142 Uris Hall</td>
<td>Evan Sorensen</td>
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MATHEMATICS-STATISTICS

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.

Special differential equations of order one. Linear differential equations with constant and variable coefficients. Systems of such equations. Transform and series solution techniques. Emphasis on applications

Spring 2024: MATH UN2030

<table>
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<th>Course Number</th>
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<th>Times/Location</th>
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<tr>
<td>MATH 2030</td>
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<td>M W 10:10am - 11:25am 203 Mathematics Building</td>
<td>Ovidiu Savin</td>
<td>3.00</td>
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<tr>
<td>MATH 2030</td>
<td>002/12346</td>
<td>T Th 11:40am - 12:55pm 142 Uris Hall</td>
<td>Yin Li</td>
<td>3.00</td>
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Fall 2024: MATH UN2030

<table>
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<tr>
<td>MATH 2030</td>
<td>001/11872</td>
<td>M W 1:10pm - 2:25pm 312 Mathematics Building</td>
<td>Panagiotis Daskalopoulos</td>
<td>3.00</td>
<td>100/100</td>
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<tr>
<td>MATH 2030</td>
<td>002/11873</td>
<td>T Th 10:10am - 11:25am 142 Uris Hall</td>
<td>Jeanne Boursier</td>
<td>3.00</td>
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<td>MATH 2030</td>
<td>003/11874</td>
<td>T Th 1:10pm - 2:25pm 520 Mathematics Building</td>
<td>Jeanne Boursier</td>
<td>3.00</td>
<td>48/49</td>
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</table>
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. Mathematical methods for economics. Quadratic forms, Hessian, implicit functions. Convex sets, convex functions. Optimization, constrained optimization, Kuhn-Tucker conditions. Elements of the calculus of variations and optimal control. (SC)

Spring 2024: MATH UN2500
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 2500 | 001/12347 | T Th 11:40am - 12:55pm 207 Mathematics Building | Wenjian Liu | 3.00 | 86/100

Fall 2024: MATH UN2500
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 2500 | 001/11875 | M W 4:10pm - 5:25pm 417 Mathematics Building | Qiao He | 3.00 | 64/64
MATH 2500 | 002/11876 | T Th 10:10am - 11:25am 517 Hamilton Hall | Roger Van Peski | 3.00 | 71/75

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 2024: MATH UN3007
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 3007 | 001/11877 | T Th 11:40am - 12:55pm 312 Mathematics Building | Ovidiu Savin | 3.00 | 80/100

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 2024: MATH UN3020
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 3020 | 001/12358 | M W 10:10am - 11:25am 207 Mathematics Building | Yoonjoo Kim | 3.00 | 70/100

MATH UN3025 MAKING, BREAKING CODES. 3.00 points.
Prerequisites: (MATH UN1101 and MATH UN1102 and MATH UN1201) and MATH UN2010.
Prerequisites: (MATH UN1101 and MATH UN1102 and MATH UN1201) and MATH UN2010. A concrete introduction to abstract algebra. Topics in abstract algebra used in cryptography and coding theory

Fall 2024: MATH UN3025
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 3025 | 001/11878 | T Th 1:10pm - 2:25pm 312 Mathematics Building | Dorian Goldfeld | 3.00 | 94/100

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 2024: MATH UN3028
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 3028 | 001/12359 | T Th 1:10pm - 2:25pm 312 Mathematics Building | Simon Brendle | 3.00 | 59/100

MATH UN3050 DISCRETE TIME MODELS IN FINANC. 3.00 points.
Prerequisites: (MATH UN1101 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 2024: MATH UN3050
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 3050 | 001/12360 | M W 6:10pm - 7:25pm 312 Mathematics Building | Mikhail Smirnov | 3.00 | 57/64

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.

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 a reading and study in mathematics. A student who wishes to undertake an 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 2024: MATH UN3901
Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment
--- | --- | --- | --- | --- | ---
MATH 3901 | 001/00790 | | Dusa McDuff | 1.00-3.00 | 0/5
MATH 3901 | 002/00791 | | Daniela De Silva | 1.00-3.00 | 0/5
MATH 3901 | 003/17561 | | Richard Hamilton | 1.00-3.00 | 0/1
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 2024: MATH UN3902

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<th>Course Number</th>
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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 2024: MATH UN3951

<table>
<thead>
<tr>
<th>Course Number</th>
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<th>Times/Location</th>
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<td>Cristian Iovanov</td>
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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 2024: MATH UN3952

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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 2024: MATH UN3994

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<thead>
<tr>
<th>Course Number</th>
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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 2024: MATH UN3995

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<th>Course Number</th>
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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

Spring 2024: MATH GU4007
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
MATH 4007 001/12361  T Th 2:40pm - 3:55pm  307 Mathematics Building  Dorian Goldfeld  3.00  8/19

MATH GU4032 FOURIER ANALYSIS. 3.00 points.
Prerequisites: three terms of calculus and linear algebra or four terms of calculus.
Prerequisites: three terms of calculus and linear algebra or four terms of calculus. Fourier series and integrals, discrete analogues, inversion and Poisson summation formulae, convolution. Heisenberg uncertainty principle. Stress on the application of Fourier analysis to a wide range of disciplines

Fall 2024: MATH GU4032
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
MATH 4032 001/11879  T Th 10:10am - 11:25am  603 Hamilton Hall  Simon Brendle  3.00  48/49

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 theorems, symmetric groups, group actions, the Sylow theorems, finitely generated abelian groups

Spring 2024: MATH GU4041
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
MATH 4041 001/12362  M W 10:10am - 11:25am  417 Mathematics Building  Yujie Xu  3.00  55/64
MATH 4041 001/11904  M W 1:10pm - 2:25pm  203 Mathematics Building  Robert Friedman  3.00  94/100

Fall 2024: MATH GU4041
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
MATH 4041 001/12366  M W 2:40pm - 3:55pm  307 Mathematics Building  Nathan Chen  3.00  5/20

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

Spring 2024: MATH GU4042
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
MATH 4042 001/12363  M W 2:40pm - 3:55pm  417 Mathematics Building  Michael Thaddeus  3.00  30/49

Fall 2024: MATH GU4042
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
MATH 4042 001/11846  M W 10:10am - 11:25am  417 Mathematics Building  Michael Thaddeus  3.00  30/49

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, finiteness of the class number, ramification. If time permits, $p$-adic numbers and Dedekind zeta function

Spring 2024: MATH GU4043
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
MATH 4043 001/12364  M W 10:10am - 11:25am  417 Mathematics Building  Gyujin Oh  3.00  43/64

MATH GU4044 REPRESENTATNS 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

Fall 2024: MATH GU4044
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
MATH 4044 001/11880  T Th 1:10pm - 2:25pm  407 Mathematics Building  Andrei Okounkov  3.00  21/30

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

Spring 2024: MATH GU4045
Course Number  Section/Call Number  Times/Location  Instructor  Points  Enrollment
MATH 4045 001/12366  M W 2:40pm - 3:55pm  307 Mathematics Building  Nathan Chen  3.00  5/20
MATH GU4051 TOPOLOGY. 3.00 points.
Prerequisites: (MATH UN1202 and MATH UN2010) and rudiments of group theory (e.g., MATH GU4041). MATH UN2018 or MATH GU4061 is recommended, but not required.
Prerequisites: (MATH UN1202 and MATH UN2010) and rudiments of group theory (e.g., MATH GU4041). MATH UN2018 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.

Fall 2024: MATH GU4051
Course Number  | Section/Call Number  | Times/Location  | Instructor  | Points  | Enrollment
--- | --- | --- | --- | --- | ---
MATH 4051  | 001/11881  | T Th 6:10pm - 7:25pm 520 Mathematics Building  | Rostislav Akhmechet  | 3.00  | 37/49

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 R³, 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.

Fall 2024: MATH GU4052
Course Number  | Section/Call Number  | Times/Location  | Instructor  | Points  | Enrollment
--- | --- | --- | --- | --- | ---
MATH 4052  | 001/11882  | M W 11:40am - 12:55pm 307 Mathematics Building  | Siddhartha Krishna  | 3.00  | 12/20

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

Spring 2024: MATH GU4053
Course Number  | Section/Call Number  | Times/Location  | Instructor  | Points  | Enrollment
--- | --- | --- | --- | --- | ---
MATH 4053  | 001/12368  | T Th 11:40am - 12:55pm 407 Mathematics Building  | Lucy Yang  | 3.00  | 14/30

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-Arzela theorem, Stone-Weierstrass theorem.

Spring 2024: MATH GU4061
Course Number  | Section/Call Number  | Times/Location  | Instructor  | Points  | Enrollment
--- | --- | --- | --- | --- | ---
MATH 4061  | 001/12541  | M W 1:10pm - 2:25pm 203 Mathematics Building  | Ivan Corwin  | 3.00  | 55/110

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.
The second term of this course may not be taken without the first. Power series, analytic functions, Implicit function theorem, Fubini theorem, change of variables formula, Lebesgue measure and integration, function spaces.

Spring 2024: MATH GU4062
Course Number  | Section/Call Number  | Times/Location  | Instructor  | Points  | Enrollment
--- | --- | --- | --- | --- | ---
MATH 4062  | 001/12540  | T Th 4:10pm - 5:25pm 417 Mathematics Building  | Nikolaos Apostolakis  | 3.00  | 14/50

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.

Fall 2024: MATH GU4065
Course Number  | Section/Call Number  | Times/Location  | Instructor  | Points  | Enrollment
--- | --- | --- | --- | --- | ---
MATH 4065  | 001/11884  | T Th 11:40am - 12:55pm 520 Mathematics Building  | Francesco Lin  | 3.00  | 39/45
MATH GU4081 INTRO-DIFFERENTIABLE MANIFOLDS. 3.00 points.
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 2024: MATH GU4081
Course Number Section/Call Number Times/Location Instructor Points Enrollment
MATH 4081 001/000234 M W 10:10am - 11:25am Ll03 Diana Center Dusa McDuff 3.00 17/40

MATH GU4155 PROBABILITY THEORY. 3.00 points.
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 2024: MATH GU4155
Course Number Section/Call Number Times/Location Instructor Points Enrollment
MATH 4155 001/12373 T Th 2:40pm - 3:55pm 520 Mathematics Building Ioannis Karatzas 3.00 27/49

Fall 2024: MATH GU4155
Course Number Section/Call Number Times/Location Instructor Points Enrollment
MATH 4155 001/11860 T Th 2:40pm - 3:55pm 717 Hamilton Hall Ivan Corwin 3.00 33/75

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

MATH GU4200 MATHEMATICS AND THE HUMANITIES. 4.00 points.
This course is being taught by two senior faculty members who are
theorists and practitioners in disciplines as different as mathematics
and literary criticism. The instructors believe that in today’s world, the
different ways in which theoretical mathematics and literary criticism
mold the imaginations of students and scholars, should be brought
together, so that the robust ethical imagination that is needed to combat
the disintegration of our world can be produced. Except for the length
of novels, the reading is no more than 100 pages a week. Our general
approach is to keep alive the disciplinary differences between literary/
philosophical (humanities) reading and mathematical writing. Some
preliminary questions we have considered are: the survival skills of the
logician school over against the Foundational Crisis of the early 20th
century; by way of Wittgenstein and others, we ask, Are mathematical
objects real? Or are they linguistic conventions? We will consider the
literary/philosophical use of mathematics, often by imaginative analogy;
and the role of the digital imagination in the humanities: Can so-called
creative work as well as mathematics be written by machines? Guest
faculty from other departments will teach with us to help students and
instructors understand various topics. We will close with how a novel
animates “science” in prose, stepping out of the silo of disciplinary
mathematics to the arena where mathematics is considered a code-name
for science: Christine Brooke-Rose’s novel Subscript

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

Fall 2024: MATH GU4391
Course Number Section/Call Number Times/Location Instructor Points Enrollment
MATH 4391 001/11885 M W 2:40pm - 3:55pm 417 Mathematics Building Peter Woit 3.00 31/64

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.