APPLIED MATHEMATICS

The Department of Mathematics

Department website: http://www.math.columbia.edu

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

Undergraduate Academic Coordinator
TBD

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 seminar 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
Prof. George Dragomir, 525 Mathematics; 212-854-2849; gd2572@columbia.edu

Computer Science-Mathematics Advisers
Computer Science: Dr. Jae Woo Lee, 715 CEPSR; 212-939-7066; jae@cs.columbia.edu
Mathematics: Prof. Chiu-Chu Melissa Liu, 623 Mathematics; 212-854-2499; ccliu@math.columbia.edu

Economics-Mathematics Advisers
Economics: Dr. Susan Elmes, 1006 International Affairs Building; 212-854-9124; se5@columbia.edu
Mathematics: Prof. Francesco Lin, 613 Mathematics; 212-854-2192; f (jd2653@columbia.edu)l2550@columbia.edu (fl2550@columbia.edu)

Mathematics-Statistics Advisers
Mathematics: Prof. Andrew Blumberg, 607 Mathematics; 212-851-9307; a (jd2653@columbia.edu)b4808@columbia.edu (ab4808@columbia.edu)
Statistics: Dr. Ronald Neath, 612 Watson; 212-853-1398; rcn2112@columbia.edu

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 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 may be evaluated for transfer credit. A maximum of 16 transfer credits may be granted. A maximum of 6 transfer credits may be counted towards minor requirements.

- 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
- Spring 2025: Profs. Aggarwal, Bayer, Li, Liu, Sawhney, Urban, 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.

Planning Forms

Planning forms for all programs are available on our website. These forms should be completed and approved by a department adviser early in the semester of the expected graduation date.

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:

MATH UN1101	CALCULUS I
& MATH UN1102	and CALCULUS II
& MATH UN1201	and CALCULUS III
& MATH UN1202	and CALCULUS IV
& MATH UN2010	and LINEAR ALGEBRA
OR	
MATH UN1101	CALCULUS I
& MATH UN1102	and CALCULUS II
& MATH UN1205	and ACCELERATED MULTIVARIABLE
& MATH UN2010	CALC
	and LINEAR ALGEBRA
OR	
MATH UN1101	CALCULUS I
& MATH UN1102	and CALCULUS II
& MATH UN1207	and HONORS MATHEMATICS A
& MATH UN1208	and HONORS MATHEMATICS B

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 or 7 on the IB Mathematics: applications and interpretation HL exam (2021 or later) or a score of 6 or 7 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 & MATH UN1102 & MATH UN1201 & MATH UN1202 & MATH UN2010	CALCULUS I and CALCULUS II and CALCULUS III and CALCULUS IV and LINEAR ALGEBRA [1]
OR	
MATH UN1101 & MATH UN1102 & MATH UN1205 & MATH UN2010	CALCULUS I and CALCULUS II and ACCELERATED MULTIVARIABLE CALC and LINEAR ALGEBRA [1]
OR	
MATH UN1101 & MATH UN1102 & MATH UN1207 & MATH UN1208	CALCULUS I and CALCULUS II and HONORS MATHEMATICS A 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]
or 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]

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. Students who have taken MATH UN2015 and consider taking higher level Math courses should contact a major advisor to discuss alternative pathways.
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.

Approved Cognate Courses 1	Approved Cognate Courses 2	Approved Cognate Courses 3
APMA E2101 INTRO TO APPLIED MATHEMATICS	ECON UN3025 FINANCIAL ECONOMICS	PHYS UN2601 PHYSICS III:CLASS/QUANTUM WAVE
APMA E3102 APPLIED MATHEMATICS II: PDE'S	ECON BC3035 INTERMEDIATE MICROECONOMICS	PHYS UN2801 ACCELERATED PHYSICS I
APMA E4300 COMPUT MATH:INTRO-NUMERCL METH	ECON BC3038 INTERNATIONAL MONEY # FINANCE	PHYS UN2802 ACCELERATED PHYSICS II
APMA E4302 METHODS IN COMPUTATIONAL SCI	ECON UN3211 INTERMEDIATE MICROECONOMICS	PHYS UN3003 MECHANICS
APPH E6102 PLASMA PHYSICS II	ECON UN3213 INTERMEDIATE MACROECONOMICS	PHYS UN3007 ELECTRICITY-MAGNETISM
CBMF W4761 COMPUTATIONAL GENOMICS	ECON UN3265 MONEY AND BANKING	PHYS UN3008 ELECTROMAGNETIC WAVES # OPTICS
CHEM UN3079 PHYSICAL CHEMISTRY I-LECTURES	ECON UN3412 INTRODUCTION TO ECONOMETRICS	PHYS GU4011 PARTICLE ASTROPHYS # COSMOLOGY
CHEM UN3080 PHYSICAL CHEMISTRY II-LECTURES	ECON GU4020 ECON OF UNCERTAINTY # INFORMTN	PHYS GU4018 SOLID STATE PHYSICS
COMS W3134 Data Structures in Java	ECON GU4230 ECONOMICS OF NEW YORK CITY	PHYS GU4019 MATHEMAT METHODS OF PHYSICS
COMS W3157 ADVANCED PROGRAMMING	ECON GU4280 CORPORATE FINANCE	PHYS GU4021 QUANTUM MECHANICS I
COMS W3203 DISCRETE MATHEMATICS	ECON GU4415 GAME THEORY	PHYS GU4022 QUANTUM MECHANICS II
COMS W3261 COMPUTER SCIENCE THEORY	ECON GU4710 FINANCE AND THE REAL ECONOMY	PHYS GU4023 THERMAL # STATISTICAL PHYSICS
COMS W4111 INTRODUCTION TO DATABASES	IEOR E6616 CONVEX OPTIMIZATION	PHYS GU4040 INTRO TO GENERAL RELATIVITY
COMS W4160 COMPUTER GRAPHICS	EESC UN3400 COMPUTATIONAL EARTH SCIENCE	PHYS GR6047 QUANTUM FIELD THEORY I
COMS W4162 Advanced Computer Graphics	EESC GU4008 Introduction to Atmospheric Science	PHYS GR6080 SCIENTIFIC COMPUTING
COMS W4203 Graph Theory	EESC GU4090 INTRO TO GEOCHRONOLGY	POLS GU4700 MATH # STATS FOR POLI SCI
COMS W4261 INTRO TO CRYPTOGRAPHY	EESC GU4924 INTRO TO ATMOSPHERIC CHEMISTRY	STAT UN3106 APPLIED MACHINE LEARNING
COMS W4460 PRIN-INNOVATN/ ENTREPRENEURSHIP	IEOR E3106 STOCHASTIC SYSTEMS AND APPLICATIONS	STAT GU4001 INTRODUCTI TO PROBABILITY AND STATISTICS
COMS W4701 ARTIFICIAL INTELLIGENCE	IEOR E3658 PROBABILITY FOR ENGINEERS	STAT GU4203 PROBABILITY THEORY
COMS W4705 NATURAL LANGUAGE PROCESSING	IEOR E4700 INTRO TO FINANCIAL ENGINEERING	STAT GU4204 STATISTICAL INFERENCE
COMS W4762 Machine Learning for Functional Genomics	IEOR E6613 Optimization I	STAT GU4205 LINEAR REGRESSION MODELS
COMS W4771 MACHINE LEARNING	MSAE E3010 FOUNDATIONS OF MATERIALS SCIENCE	STAT GU4206 STAT COMP # INTRO DATA SCIENCE
COMS W4773 Machine Learning Theory	MSAE E3111 THERMO/ KINETIC THRY/STAT MECH	STAT GU4207 ELEMENTARY STOCHASTIC PROCESS
CSEE W3827 FUNDAMENTALS OF COMPUTER SYSTS	PHIL UN3411 SYMBOLIC LOGIC	
CSOR W4231 ANALYSIS OF ALGORITHMS I	PHIL GU4424 MODAL LOGIC	
CSOR W4246 ALGORITHMS FOR DATA SCIENCE	PHIL GU4431 INTRODUCTION TO SET THEORY	
CSPH G4801	PHIL GU4561 PROBABILITY # DECISION THEORY	
CSPH G4802 Math Logic II: Incompletness	PHIL GU4810 LATTICES AND BOOLEAN ALGEBRA	

Major in Applied Mathematics

The major requires 37-41 points as follows:

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

MATH UN1101 & MATH UN1102 & MATH UN1201 & MATH UN1202 & MATH UN2010	CALCULUS I and CALCULUS II and CALCULUS III and CALCULUS IV and LINEAR ALGEBRA [1]

OR

MATH UN1101 & MATH UN1102 & MATH UN1205 & MATH UN2010	CALCULUS I and CALCULUS II and ACCELERATED MULTIVARIABLE CALC and LINEAR ALGEBRA [1]

OR

MATH UN1101 & MATH UN1102 & MATH UN1207 & MATH UN1208	CALCULUS I and CALCULUS II and HONORS MATHEMATICS A 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

Take each of the following two required courses:

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 in Track A electives, or at least 9 points in Track B electives. A maximum of 9 points may be selected from courses outside these tracks, with prior written approval from the Director of Undergraduate Studies.

TRACK A

MATH UN2500	ANALYSIS AND OPTIMIZATION
MATH UN2030	ORDINARY DIFFERENTIAL EQUATIONS
MATH UN3007	COMPLEX VARIABLES
or MATH GU4065	HONORS COMPLEX VARIABLES
or APMA E4204	FUNCTNS OF A COMPLEX VARIABLE
MATH UN3028	PARTIAL DIFFERENTIAL EQUATIONS
or APMA E3102	APPLIED MATHEMATICS II: PDE'S
or APMA E4200	PARTIAL DIFFERENTIAL EQUATIONS
MATH GU4032	FOURIER ANALYSIS
MATH GU4061	INTRO MODERN ANALYSIS I
MATH GU4062	INTRO MODERN ANALYSIS II
APMA E4100	Applied Analysis
APMA E4101	APPL MATH III:DYNAMICAL SYSTMS
APMA E4150	APPLIED FUNCTIONAL ANALYSIS

APMA E4300	COMPUT MATH:INTRO-NUMERCL METH
APMA E4301	NUMERICAL METHODS/PDE'S
APMA E6301	ANALYTIC METHODS FOR PDE'S
APMA E6302	NUMERICAL ANALYSIS OF PDE'S
TRACK B	
COMS W3203	DISCRETE MATHEMATICS
COMS W3261	COMPUTER SCIENCE THEORY
COMS W4231	ANALYSIS OF ALGORITHMS I
COMS W4261	INTRO TO CRYPTOGRAPHY
MATH UN3050	DISCRETE TIME MODELS IN FINANC
MATH GU4155	PROBABILITY THEORY
or IEOR E3658	PROBABILITY FOR ENGINEERS
or STAT GU4203	PROBABILITY THEORY
MATH GU4156	ADVANCED PROBABILITY THEORY
IEOR E3106	STOCHASTIC SYSTEMS AND APPLICATIONS
or STAT GU4207	ELEMENTARY STOCHASTIC PROCESS
APMA E4008	Advanced and Applied Linear Algebra
APMA E4306	Applied Stochastic Analysis
ECON GU4415	GAME THEORY

[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. Students who have taken MATH UN2015 and consider taking higher level Math courses should contact a major advisor to discuss alternative pathways.

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	
COMS W1004	Introduction to Computer Science and Programming in Java
or COMS W1007	
COMS W3134	Data Structures in Java
or COMS W3137	HONORS DATA STRUCTURES # ALGOL
COMS W3157	ADVANCED PROGRAMMING
COMS W3203	DISCRETE MATHEMATICS
COMS W3261	COMPUTER SCIENCE THEORY
CSEE W3827	FUNDAMENTALS OF COMPUTER SYSTS
Mathematics	
Select one of the following three calculus and linear algebra sequences (13-15 points including Advanced Placement Credit):	
MATH UN1101 & MATH UN1102 & MATH UN1201 & MATH UN1202 & MATH UN2010	CALCULUS I and CALCULUS II and CALCULUS III and CALCULUS IV and LINEAR ALGEBRA [1]
OR	
MATH UN1101 & MATH UN1102 & MATH UN1205 & MATH UN2010	CALCULUS I and CALCULUS II and ACCELERATED MULTIVARIABLE CALC and LINEAR ALGEBRA [1]
OR	
MATH UN1101 & MATH UN1102 & MATH UN1207 & MATH UN1208	CALCULUS I and CALCULUS II and HONORS MATHEMATICS A and HONORS MATHEMATICS B
MATH UN3951	UNDERGRADUATE SEMINARS I
or MATH UN3952	UNDERGRADUATE SEMINARS II
MATH GU4041	INTRO MODERN ALGEBRA I
Electives	
Select two of the following courses:	
MATH BC2006	COMBINATORICS
MATH UN2030	ORDINARY DIFFERENTIAL EQUATIONS
MATH UN2500	ANALYSIS AND OPTIMIZATION
MATH UN3007	COMPLEX VARIABLES
MATH UN3020	NUMBER THEORY AND CRYPTOGRAPHY
MATH UN3025	MAKING, BREAKING CODES
MATH UN3028	PARTIAL DIFFERENTIAL EQUATIONS
MATH UN3386	DIFFERENTIAL GEOMETRY
MATH GU4032	FOURIER ANALYSIS
MATH GU4042	INTRO MODERN ALGEBRA II
MATH GU4051	TOPOLOGY
MATH GU4053	INTRO TO ALGEBRAIC TOPOLOGY
MATH GU4061	INTRO MODERN ANALYSIS I
MATH GU4062	INTRO MODERN ANALYSIS II
COMS W4111	INTRODUCTION TO DATABASES
COMS W4113	FUND-LARGE-SCALE DIST SYSTEMS
COMS W4115	PROGRAMMING LANG # TRANSLATORS
COMS W4118	OPERATING SYSTEMS I
COMS W4119	COMPUTER NETWORKS
COMS W4152	Engineering Software-as-a-Service
COMS W4156	ADVANCED SOFTWARE ENGINEERING
COMS W4160	COMPUTER GRAPHICS
COMS W4167	COMPUTER ANIMATION
COMS W4170	USER INTERFACE DESIGN
COMS W4181	SECURITY I
CSOR E4231	ANALYSIS OF ALGORITHMS I
COMS W4236	INTRO-COMPUTATIONAL COMPLEXITY
COMS W4701	ARTIFICIAL INTELLIGENCE
COMS W4705	NATURAL LANGUAGE PROCESSING
COMS W4731	Computer Vision I: First Principles
COMS W4733	COMPUTATIONAL ASPECTS OF ROBOTICS
CBMF W4761	COMPUTATIONAL GENOMICS
COMS W4771	MACHINE LEARNING
CSEE W4824	COMPUTER ARCHITECTURE
CSEE W4868	SYSTEM-ON-CHIP PLATFORMS

[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. Students who have taken MATH UN2015 and consider taking higher level Math courses should contact a major advisor to discuss alternative pathways.

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:	
MATH UN1101	CALCULUS I
& MATH UN1102	and CALCULUS II
& MATH UN1201	and CALCULUS III
& MATH UN2010	and LINEAR ALGEBRA
& MATH UN2500	and ANALYSIS AND OPTIMIZATION [1]
OR	
MATH UN1101	CALCULUS I
& MATH UN1102	and CALCULUS II
& MATH UN1205	and ACCELERATED MULTIVARIABLE
& MATH UN2010	CALC
& MATH UN2500	and LINEAR ALGEBRA
	and ANALYSIS AND OPTIMIZATION [1]
OR	
MATH UN1207	HONORS MATHEMATICS A
& MATH UN1208	and HONORS MATHEMATICS B
& MATH UN2500	and ANALYSIS AND OPTIMIZATION (with approval from the adviser)
Statistics	
Introductory Course	
STAT UN1201	CALC-BASED INTRO TO STATISTICS
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	STOCHASTC PROCSSES-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
ENGI E1006	INTRO TO COMP FOR ENG/APP SCI
COMS W1007	
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] 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. Students who have taken MATH UN2015 and consider taking higher level Math courses should contact a major advisor to discuss alternative pathways.

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 .

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[1]. 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 & MATH UN2010	CALCULUS IV and LINEAR ALGEBRA
OR	
MATH UN1202 & MATH UN2015	CALCULUS IV and Linear Algebra and Probability
OR	
MATH UN1205 & MATH UN2010	ACCELERATED MULTIVARIABLE CALC and LINEAR ALGEBRA
OR	
MATH UN1205 & MATH UN2015	ACCELERATED MULTIVARIABLE CALC and Linear Algebra and Probability
OR	
MATH UN1207 & MATH UN1208	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. [1]	
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 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	
MATH UN1201 & MATH UN2010	CALCULUS III and LINEAR ALGEBRA
OR	
MATH UN1201 & MATH UN2015	CALCULUS III and Linear Algebra and Probability
OR	
MATH UN1205 & MATH UN2010	ACCELERATED MULTIVARIABLE CALC and LINEAR ALGEBRA
OR	
MATH UN1205 & MATH UN2015	ACCELERATED MULTIVARIABLE CALC and Linear Algebra and Probability
OR	
MATH UN1207 & MATH UN1208	HONORS MATHEMATICS A and HONORS MATHEMATICS B
Probability Theory	
MATH GU4155	PROBABILITY THEORY
or STAT GU4203	PROBABILITY THEORY
or IEOR E3658	PROBABILITY FOR ENGINEERS
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.	
Approved Mathematics Electives	
MATH UN2030	ORDINARY DIFFERENTIAL EQUATIONS
MATH UN2500	ANALYSIS AND OPTIMIZATION
MATH UN3028	PARTIAL DIFFERENTIAL EQUATIONS
MATH UN3050	DISCRETE TIME MODELS IN FINANC
MATH GU4061	INTRO MODERN ANALYSIS I
MATH GU4062	INTRO MODERN ANALYSIS II
MATH GU4156	ADVANCED PROBABILITY THEORY
Approved Cognate Electives	
COMS W3203	DISCRETE MATHEMATICS
IEOR E3106	STOCHASTIC SYSTEMS AND APPLICATIONS
PHIL GU4561	PROBABILITY # DECISION THEORY
PHYS GU4023	THERMAL # STATISTICAL PHYSICS
STAT GU4204	STATISTICAL INFERENCE
STAT GU4207	ELEMENTARY STOCHASTIC PROCESS
STAT GU4262	Stochastic Processes for Finance
STAT GU4264	STOCHASTC PROCSSES-APPLICTNS I

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 GU4203 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 & MATH UN1202 & MATH UN2010	CALCULUS III and CALCULUS IV and LINEAR ALGEBRA [1]
OR	
MATH UN1205 & MATH UN2010	ACCELERATED MULTIVARIABLE CALC and LINEAR ALGEBRA [1]
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. [2]	

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. Students who have taken MATH UN2015 and consider taking higher level Math courses should contact a major advisor to discuss alternative pathways.
2. For mathematics courses taken in other departments, consult with the Director of Undergraduate Studies.

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. This course may not be taken for credit after the successful completion of any course in the Calculus sequence

Spring 2025: MATH UN1003

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 1003	001/15269	M W 11:40am - 12:55pm 407 Mathematics Building	Jiahe Shen	3.00	10/30
MATH 1003	002/15270	T Th 6:10pm - 7:25pm 407 Mathematics Building	Xiaorun Wu	3.00	22/30

MATH UN1101 CALCULUS I. *3.00 points*.
Prerequisites: see Courses for First-Year Students. Functions, limits, derivatives, introduction to integrals.
Prerequisites: (see Courses for First-Year Students). Functions, limits, derivatives, introduction to integrals, or an understanding of pre-calculus will be assumed. (SC)

Spring 2025: MATH UN1101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 1101	001/00472	M W 1:10pm - 2:25pm 263 Macy Hall	Dusa McDuff	3.00	62/90
MATH 1101	002/15277	M W 4:10pm - 5:25pm 407 Mathematics Building	Qiyao Yu	3.00	23/30
MATH 1101	003/15278	M W 6:10pm - 7:25pm 312 Mathematics Building	Brian Harvie	3.00	102/100
MATH 1101	004/15280	T Th 10:10am - 11:25am 614 Schermerhorn Hall	Roger Van Peski	3.00	24/100
MATH 1101	005/15281	T Th 1:10pm - 2:25pm 207 Mathematics Building	Roger Van Peski	3.00	22/100
MATH 1101	006/15282	T Th 4:10pm - 5:25pm 407 Mathematics Building	Che Shen	3.00	20/30

Fall 2025: MATH UN1101

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 1101	001/00293		Dusa McDuff	3.00	0/55
MATH 1101	002/00294		0. FACULTY	3.00	0/55
MATH 1101	003/00295		0. FACULTY	3.00	0/55
MATH 1101	004/00296		0. FACULTY	3.00	0/55

MATH UN1102 CALCULUS II. *3.00 points*.
Prerequisites: MATH UN1101 *MATH V1101* or the equivalent.
Prerequisites: MATH UN1101 or the equivalent. Methods of integration, applications of the integral, Taylors theorem, infinite series. (SC)

Spring 2025: MATH UN1102

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 1102	001/00477	T Th 2:40pm - 3:55pm Ll002 Milstein Center	Lindsay Piechnik	3.00	88/90
MATH 1102	002/15285	M W 10:10am - 11:25am 312 Mathematics Building	Evan Sorensen	3.00	49/100
MATH 1102	003/00493	M W 11:40am - 12:55pm 323 Milbank Hall	Wenjian Liu	3.00	38/100
MATH 1102	004/15287	M W 4:10pm - 5:25pm 606 Martin Luther King Building	Jingbo Wan	3.00	27/30
MATH 1102	005/15289	T Th 10:10am - 11:25am 417 Mathematics Building	Peter Woit	3.00	20/64
MATH 1102	006/15291	T Th 11:40am - 12:55pm 203 Mathematics Building	Dawei Shen	3.00	23/100
MATH 1102	007/15294	T Th 1:10pm - 2:25pm 312 Mathematics Building	Andres Ibanez Nunez	3.00	8/100

Fall 2025: MATH UN1102

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 1102	001/00297		0. FACULTY	3.00	0/65
MATH 1102	002/00298		0. FACULTY	3.00	0/65

MATH UN1201 CALCULUS III. *3.00 points*.
Prerequisites: MATH UN1101 *MATH V1101* 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)

Spring 2025: MATH UN1201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 1201	001/00494	M W 10:10am - 11:25am 405 Milbank Hall	Cristian Iovanov	3.00	30/90
MATH 1201	002/00496	M W 11:40am - 12:55pm 405 Milbank Hall	Cristian Iovanov	3.00	56/90
MATH 1201	003/15298	M W 2:40pm - 3:55pm 312 Mathematics Building	Deeparaj Bhat	3.00	94/100
MATH 1201	004/15300	T Th 1:10pm - 2:25pm 203 Mathematics Building	Deeparaj Bhat	3.00	85/100
MATH 1201	005/15301	T Th 4:10pm - 5:25pm 203 Mathematics Building	Rostislav Akhmechet	3.00	90/100
MATH 1201	006/15302	T Th 6:10pm - 7:25pm 203 Mathematics Building	Rostislav Akhmechet	3.00	89/100

Fall 2025: MATH UN1201

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 1201	001/00300		Daniela De Silva	3.00	0/65
MATH 1201	002/00301		0. FACULTY	3.00	0/65
MATH 1201	003/00302		0. FACULTY	3.00	0/65

MATH UN1202 CALCULUS IV. *3.00 points*.
Prerequisites: MATH UN1102 and MATH UN1201 *MATH V1102*, *MATH V1201*, 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 2025: MATH UN1202

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 1202	001/15304	M W 1:10pm - 2:25pm 312 Mathematics Building	Ovidiu Savin	3.00	47/64
MATH 1202	002/15306	T Th 1:10pm - 2:25pm 417 Mathematics Building	Marco Sangiovanni Vincentelli	3.00	38/64

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 2025: MATH UN1205

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 1205	001/15308	T Th 11:40am - 12:55pm 520 Mathematics Building	Marco Castronovo	4.00	31/64

MATH UN1207 HONORS MATHEMATICS A. *4.00 points*.
Prerequisites: (see Courses for First-Year Students).
Prerequisites: (see "Guidance for First-Year Students" in the Bulletin).
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).
Prerequisites: (see "Guidance for First-Year Students" in the Bulletin).
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 2025: MATH UN1208

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 1208	001/15314	T Th 1:10pm - 2:25pm 330 Uris Hall	Jeanne Boursier	4.00	30/64

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 2025: MATH UN2000

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 2000	001/15319	T Th 1:10pm - 2:25pm 520 Mathematics Building	Giulia Sacca	3.00	34/49

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 2025: MATH BC2001

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 2001	001/00904	W 2:40pm - 3:30pm 140 Horace Mann Hall	Dusa McDuff	1.00	17/30

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 2025: MATH UN2005

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 2005	001/15321	F 1:00pm - 3:00pm 417 Mathematics Building	Julien Dubedat	0.00	38/50

MATH BC2006 COMBINATORICS. *3.00 points*.

Spring 2025: MATH BC2006

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 2006	001/00860	T Th 10:10am - 11:25am 408 Zankel	Alisa Knizel	3.00	27/60

MATH UN2010 LINEAR ALGEBRA. *3.00 points*.
Prerequisites: *MATH V1201*, or the equivalent.
Matrices, vector spaces, linear transformations, eigenvalues and eigenvectors, canonical forms, applications. (SC)

Spring 2025: MATH UN2010

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 2010	001/00487	M W 8:40am - 9:55am 263 Macy Hall	Wenjian Liu	3.00	82/100
MATH 2010	002/00491	M W 2:40pm - 3:55pm LI002 Milstein Center	Lindsay Piechnik	3.00	79/90
MATH 2010	003/15325	T Th 10:10am - 11:25am 312 Mathematics Building	Qiao He	3.00	62/100
MATH 2010	004/15328	T Th 11:40am - 12:55pm 312 Mathematics Building	Qiao He	3.00	78/100
MATH 2010	005/15331	T Th 4:10pm - 5:25pm 312 Mathematics Building	Elliott Stein	3.00	55/64

Fall 2025: MATH UN2010

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 2010	001/00303		0. FACULTY	3.00	0/70

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 or MATH UN1207 Honors Math A, which focus 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. Students who have taken MATH UN2015 and consider taking higher level Math courses should contact a major advisor to discuss alternative pathways

Spring 2025: MATH UN2015

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 2015	001/15339	M W 2:40pm - 3:55pm 207 Mathematics Building	George Dragomir	3.00	101/130

MATH UN2030 ORDINARY DIFFERENTIAL EQUATIONS. *3.00 points*.
Prerequisites: MATH UN1102 and MATH UN1201 *MATH V1102-MATH V1201* 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 2025: MATH UN2030

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 2030	001/15344	M W 10:10am - 11:25am 207 Mathematics Building	Dawei Shen	3.00	70/100
MATH 2030	002/15345	T Th 11:40am - 12:55pm 207 Mathematics Building	Panagiota Daskalopoulos	3.00	98/100

MATH UN2500 ANALYSIS AND OPTIMIZATION. *3.00 points*.
Prerequisites: MATH UN1102 and MATH UN1201 *MATH V1102-MATH V1201* or the equivalent and *MATH V2010*.
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 2025: MATH UN2500

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 2500	001/15346	T Th 10:10am - 11:25am 203 Mathematics Building	Xi Shen	3.00	100/100

MATH UN3007 COMPLEX VARIABLES. *3.00 points*.
Prerequisites: MATH UN1202 *MATH V1202*. 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)

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 2025: MATH UN3020

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 3020	001/15349	M W 10:10am - 11:25am 203 Mathematics Building	Siddhi Krishna	3.00	52/100

MATH UN3025 MAKING, BREAKING CODES. *3.00 points*.
Prerequisites: (MATH UN1101 and MATH UN1102 and MATH UN1201) and *MATH V1101, MATH V1102, MATH V1201* and *MATH V2010*.
Prerequisites: (MATH UN1101 and MATH UN1102 and MATH UN1201) and and MATH UN2010. A concrete introduction to abstract algebra. Topics in abstract algebra used in cryptography and coding theory

MATH UN3028 PARTIAL DIFFERENTIAL EQUATIONS. *3.00 points*.
Prerequisites: MATH UN3027 and MATH UN2010 *MATH V3027* and *MATH V2010* 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 2025: MATH UN3028

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 3028	001/15351	T Th 2:40pm - 3:55pm 417 Mathematics Building	Simon Brendle	3.00	60/64

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 *MATH V1102, MATH V1201* (or *MATH V1101, MATH V1102, MATH V1201*), *MATH V2010*.
Recommended: *MATH V3027* (or *MATH V2030*) 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 2025: MATH UN3050

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 3050	001/15353	M W 6:10pm - 7:25pm 417 Mathematics Building	Mikhail Smirnov	3.00	57/64

MATH UN3386 DIFFERENTIAL GEOMETRY. *3.00 points*.
Prerequisites: MATH UN1202 *MATH V1202* or the equivalent.
Local and global differential geometry of submanifolds of Euclidiean 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 staff member who agrees to act as sponsor (sponsorship limited to full-time instructors on the staff list), as well as the director of undergraduate studies' permission. *The written permission must be deposited with the director of undergraduate studies before registration is completed.*
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

MATH UN3902 SUPERVISED READINGS II. *1.00-3.00 points*.
Prerequisites: the written permission of the staff member who agrees to act as sponsor (sponsorship limited to full-time instructors on the staff list), as well as the director of undergraduate studies' permission. *The written permission must be deposited with the director of undergraduate studies before registration is completed.*
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 2025: MATH UN3902

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 3902	001/18893		Julien Dubedat	1.00-3.00	1/1
MATH 3902	002/19180		Francesco Lin	1.00-3.00	1/1
MATH 3902	003/20518		Ioannis Karatzas	1.00-3.00	1/1
MATH 3902	004/20587		Andrei Okounkov	1.00-3.00	2/2
MATH 3902	005/20764		Michael Thaddeus	1.00-3.00	1/1

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 2025: MATH UN3951

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 3951	001/00304		Alisa Knizel	3.00	0/64

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 2025: MATH UN3952

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 3952	001/00804	T Th 11:40am - 12:55pm LI002 Milstein Center	Alisa Knizel	3.00	48/80

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

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 2025: MATH UN3995

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 3995	001/00919		Alisa Knizel	2.00	1/2
MATH 3995	002/00921		Dusa McDuff	2.00	1/2
MATH 3995	003/20593		Andrew Blumberg	2.00	0/1
MATH 3995	004/20594		Duong Phong	2.00	1/2
MATH 3995	005/20595		Ivan Corwin	2.00	1/1
MATH 3995	007/20715		Mu-Tao Wang	2.00	1/1

MATH GU4007 ANALYTIC NUMBER THEORY. *3.00 points*.
Prerequisites: MATH UN3007 *MATH V3007*.
Prerequisites: MATH UN3007 A one semeser 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 2025: MATH GU4007

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 4007	001/15355	T Th 2:40pm - 3:55pm 307 Mathematics Building	Amadou Bah	3.00	4/20

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. Prerequisite: 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

MATH GU4041 INTRO MODERN ALGEBRA I. *3.00 points*.
Prerequisites: MATH UN1102 and MATH UN1202 and MATH UN2010 *MATH V1102-MATH V1202* and *MATH V2010*, 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 2025: MATH GU4041

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 4041	001/15358	M W 2:40pm - 3:55pm 417 Mathematics Building	Michael Thaddeus	3.00	58/64

MATH GU4042 INTRO MODERN ALGEBRA II. *3.00 points*.
Prerequisites: MATH UN1102 and MATH UN1202 and MATH UN2010 *MATH V1102-MATH V1202* and *MATH V2010*, 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 2025: MATH GU4042

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 4042	001/15360	M W 2:40pm - 3:55pm 520 Mathematics Building	Robert Friedman	3.00	38/49

MATH GU4043 ALGEBRAIC NUMBER THEORY. *3.00 points*.
Prerequisites: MATH GU4041 and MATH GU4042 *MATH W4041-MATH W4042* 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 2025: MATH GU4043

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 4043	001/15362	T Th 4:10pm - 5:25pm 307 Mathematics Building	Yujie Xu	3.00	2/20

MATH GU4044 REPRESENTATNS OF FINITE GROUPS. *3.00 points*.
Prerequisites: MATH UN2010 and MATH GU4041 *MATH V2010* and *MATH W4041* 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 *MATH W4041*, *MATH W4042* and *MATH V3007*.
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 2025: MATH GU4045

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 4045	001/15365	M W 11:40am - 12:55pm 307 Mathematics Building	Yoonjoo Kim	3.00	6/20

MATH GU4051 TOPOLOGY. *3.00 points*.
Prerequisites: (MATH UN1202 and MATH UN2010) and *MATH V1202, MATH V2010,* and rudiments of group theory (e.g., *MATH W4041*). *MATH V1208* or *MATH W4061* 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. The study of algebraic and geometric properties of knots in R#3, including but not limited to knot projections and Reidemeisters theorm, 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 *MATH V2010*, *MATH W4041*, *MATH W4051*.
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 2025: MATH GU4053

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 4053	001/15367	T Th 11:40am - 12:55pm 307 Mathematics Building	Soren Galatius	3.00	12/20

MATH GU4061 INTRO MODERN ANALYSIS I. *3.00 points*.
Prerequisites: MATH UN1202 *MATH V1202* or the equivalent, and *MATH V2010*. 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 2025: MATH GU4061

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 4061	001/15369	M W 1:10pm - 2:25pm 614 Schermerhorn Hall	Julien Dubedat	3.00	49/100

MATH GU4062 INTRO MODERN ANALYSIS II. *3.00 points*.
Prerequisites: MATH UN1202 *MATH V1202* or the equivalent, and *MATH V2010*. 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 2025: MATH GU4062

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 4062	001/15370	T Th 4:10pm - 5:25pm 520 Mathematics Building	Francesco Lin	3.00	49/49

MATH GU4065 HONORS COMPLEX VARIABLES. *3.00 points*.
Prerequisites: (MATH UN1207 and MATH UN1208) or MATH GU4061 *MATH V1207* and *MATH V1208* or *MATH W4061*.
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 *MATH W4051* or *MATH W4061* and *MATH V2010*.
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 Sards theorem. Intersection theory. Orientations. Poincare-Hopf theorem. Differential forms and Stokes theorem

Spring 2025: MATH GU4081

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 4081	001/15373	M W 10:10am - 11:25am 520 Mathematics Building	Sven Hirsch	3.00	20/49

MATH GU4155 PROBABILITY THEORY. *3.00 points*.
Prerequisites: MATH GU4061 or MATH UN3007 *MATH W4061* or *MATH V3007*.
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

MATH GU4156 ADVANCED PROBABILITY THEORY. *3.00 points*.
This course will cover advance 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

Spring 2025: MATH GU4156

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 4156	001/15375	T Th 2:40pm - 3:55pm 332 Uris Hall	Ioannis Karatzas	3.00	25/49

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 logicist 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

Spring 2025: MATH GU4200

Course Number	Section/Call Number	Times/Location	Instructor	Points	Enrollment
MATH 4200	001/15379	T 4:10pm - 6:00pm 301m Fayerweather	Michael Harris, Justin Clarke-Doane	4.00	19/20

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.