

MATHEMATICS

332G Milbank Hall
212-854-3577

Department Assistant: Marsha Peruo

General Information

Students who have special placement problems, or are unclear about their level, should make an appointment with a faculty member or the Chair.

Two help rooms, one in 404 Mathematics and one in 502 Milstein Center, are available. Hours will be posted on the door and on <https://math.barnard.edu/math-tutoring-schedules> for students seeking individual help and counseling from Barnard tutors and Columbia teaching assistants. No appointments are necessary. Both Barnard and Columbia students are welcome. NOTE: Changes to tutoring schedules and remote tutoring can occur in response to COVID-19.

Courses for First-Year Students

The systematic study of Mathematics begins with one of the following alternative sequences:

Calculus I, II, III, IV

MATH UN1101 CALCULUS I

MATH UN1102 CALCULUS II

MATH UN1201 Calculus III

MATH UN1202 CALCULUS IV

Honors Math A-B

MATH UN1207 Honors Mathematics A

MATH UN1208 HONORS MATHEMATICS B

Credit is allowed for only one of the calculus sequences. The calculus sequence is a standard course in differential and integral calculus. *Honors Mathematics A-B* is for exceptionally well-qualified students who have strong advanced placement scores. It covers second-year Calculus (MATH UN1201 Calculus III–MATH UN1202 CALCULUS IV) and MATH UN2010 LINEAR ALGEBRA, with an emphasis on theory.

Calculus II is NOT a prerequisite for *Calculus III*, so students who plan to take only one year of calculus may choose between I and II or I and III. The latter requires a B or better in Calculus I and is a recommended option for some majors.

MATH UN2000 INTRO TO HIGHER MATHEMATICS is a course that can be taken in their first or second year by students with an aptitude for mathematics who would like to practice writing and understanding mathematical proofs.

Placement in the Calculus Sequence

College Algebra and Analytical Geometry is a refresher course for students who intend to take Calculus but do not have adequate background for it.

Advanced Placement: Students who have passed the advanced placement test for Calculus AB with a grade of 4 or 5 or BC with a grade of 4 receive 3 points of credit. Those who passed Calculus BC with a grade of 5 will receive 4 points of credit or 6 points on placing into Calculus III or Honors Math A and completing with a grade of C or better.

Calculus I, II, III: Students who have not previously studied calculus should begin with Calculus I. Students with 4 or higher on the Calculus AB or BC advanced placement test may start with Calculus II. Students with 5 on the Calculus BC test should start with Calculus III.

Honors Mathematics A: Students who have passed the Calculus BC advanced placement test with a grade of 5, and who have strong mathematical talent and motivation, should start with Honors Mathematics A. This is the most attractive course available to well-prepared, mathematically talented first-year students, whether or not they intend to be mathematics majors. Students who contemplate taking this course should consult with the instructor. If this is not possible ahead of time, they should register and attend the first class.

Chair: Daniela De Silva (Professor)

Professors: Dave Bayer, Daniela De Silva, Dusa McDuff (Helen Lyttle Kimmel Chair)

Term Assistant Professor: Lindsay Piechnik

Professors Emeriti: Joan Birman, Walter Neumann

Links to other faculty of Columbia University offering courses in Mathematics:

Faculty by Rank: <http://www.math.columbia.edu/people/faculty-by-rank/>

Alphabetical Faculty Listing: <http://www.math.columbia.edu/people/alphabetical-faculty-listing/>

Requirements for the Major

The major programs in both Mathematics and Applied Mathematics are appropriate for students who plan to continue their training in graduate school. The major in Mathematical Sciences combines the elements of Mathematics, Computer Science and Statistics. It is designed to prepare students for employment in business, administration, and finance, and also give excellent background for someone planning graduate study in a social science field. Students who plan to obtain a teaching qualification in mathematics should plan their course of study carefully with an advisor, since courses that are too far from mathematics do not count towards certification.

For a major in Mathematics: 14 courses (a minimum of 35 credits) as follows:

Four courses in calculus or Honors Mathematics A-B, including Advanced Placement Credit. Six courses in mathematics numbered at or above 2000, and four courses in any combination of mathematics and cognate courses. The courses in mathematics must include:

| | |
|----------------|---|
| MATH UN2010 | LINEAR ALGEBRA (also satisfied by Honors Math A-B) |
| MATH GU4041 | INTRO MODERN ALGEBRA I (I) |
| MATH GU4042 | INTRO MODERN ALGEBRA II (II) |
| MATH GU4061 | INTRO MODERN ANALYSIS I (I) |
| MATH GU4062 | INTRO MODERN ANALYSIS II (II) |
| MATH UN3951 | Undergraduate Seminars in Mathematics I (at least one term) |
| or MATH UN3952 | Undergraduate Seminars in Mathematics II |

* Note: It is strongly recommended that the sequences MATH GU4041 INTRO MODERN ALGEBRA I - MATH GU4062 INTRO MODERN ANALYSIS II and MATH GU4061 INTRO MODERN ANALYSIS I - MATH GU4062 INTRO MODERN ANALYSIS II be taken in separate years.

However, students who are not contemplating graduate study in mathematics may replace one or both of the two terms of MATH GU4061 INTRO MODERN ANALYSIS I - MATH GU4062 INTRO MODERN ANALYSIS II by one or two of the following courses: MATH UN2500 ANALYSIS AND OPTIMIZATION, MATH UN3007 Complex Variables, or MATH GU4032 Fourier Analysis and may replace MATH GU4042 INTRO MODERN ALGEBRA II by one of MATH UN3020 Number Theory and Cryptography or MATH UN3025 Making, Breaking Codes. In exceptional cases, the chair will approve the substitution of certain more advanced courses for those mentioned above.

For a major in Applied Mathematics: 14 courses (a minimum of 35 credits)

Four courses in calculus or Honors Mathematics A-B, including Advanced Placement Credit.

| | |
|-------------|--|
| MATH UN2010 | LINEAR ALGEBRA (also satisfied by Honors Math A-B) |
| MATH GU4061 | INTRO MODERN ANALYSIS I |
| APMA E4901 | Seminar: Problem in Applied Mathematics |
| APMA E4903 | Seminar: Problems in Applied Mathematics |
| APMA E3900 | Undergraduate Research in Applied Mathematics (APMA E3900 may be replaced, with approval, by another technical elective for seniors that involves an undergraduate thesis or creative research report) |

Additional electives, to be approved by the Applied Math Committee, e.g.:

| | |
|--|--|
| MATH UN2500 | ANALYSIS AND OPTIMIZATION |
| MATH UN3007 or MATH GU4065 or APMA E4204 | Complex Variables Honors Complex Variables FUNCTNS OF A COMPLEX VARIABLE |
| MATH UN3027 or MATH UN2030 | Ordinary Differential Equations ORDINARY DIFFERENTIAL EQUATION |
| MATH UN3028 or APMA E4200 | PARTIAL DIFFERENTIAL EQUATIONS Partial Differential Equations |
| MATH GU4032 | Fourier Analysis |
| APMA E4300 | Computational Math: Introduction to Numerical Methods |
| APMA E4101 | Introduction to Dynamical Systems |
| APMA E4150 | Applied Functional Analysis |

For a major in Mathematical Sciences: 14 courses (a minimum of 38 credits):

6 from Mathematics, 5 from a combination of Statistics and Computer Science and 3 electives from a combination of Mathematics, Statistics, Computer Science.

Mathematics

Six required courses:

| | |
|-------------|------------|
| MATH UN1101 | CALCULUS I |
|-------------|------------|

| | |
|---|---|
| MATH UN1102 | CALCULUS II |
| MATH UN1201 | Calculus III |
| MATH UN2010 | LINEAR ALGEBRA (also satisfied by Honors Math A-B) |
| MATH UN2000 | INTRO TO HIGHER MATHEMATICS |
| MATH UN2030 or MATH UN3027 | ORDINARY DIFFERENTIAL EQUATION Ordinary Differential Equations |
| Possible further courses selected from the following: | |
| MATH UN1202 | CALCULUS IV |
| MATH UN2500 | ANALYSIS AND OPTIMIZATION |
| MATH UN3020 | Number Theory and Cryptography |
| MATH UN3025 | Making, Breaking Codes |
| Any 3 credit MATH course numbered 2000 or above | |

Statistics

Select at least one of the following:

| | |
|-------------|---|
| STAT UN1101 | Introduction to Statistics |
| STAT UN1201 | Calculus-Based Introduction to Statistics |

or equivalent

Other courses from the Statistics list (eg, STAT UN2102, STAT UN2103, STAT UN2104, STAT UN3105, STAT UN3106)

Computer Science

Select at least one of the following programming courses:

| | |
|------------|--|
| COMS W1002 | Computing in Context |
| COMS W1004 | Introduction to Computer Science and Programming in Java (preferred) |
| COMS W1005 | Introduction to Computer Science and Programming in MATLAB |
| COMS W1007 | Honors Introduction to Computer Science |

Possible further courses selected from the following:

| | |
|--|--|
| Other classes from the Computer Science Core | |
| COMS W3203 | DISCRETE MATHEMATICS |
| COMS W3210 | Scientific Computation |
| ENGI E1006 | Introduction to Computing for Engineers and Applied Scientists |

More generally, electives may be any course with a prerequisite of at least one semester of Calculus, Statistics or Computer Science with the prior approval of the Mathematics Chair.

The Capstone Experience can be fulfilled by a significant thesis written under the supervision of faculty of any one of the three departments or by the Undergraduate Seminar in Mathematics.

For a major in Mathematics-Statistics: 14 courses (a minimum of 38 credits):

Mathematics

Select one of the following sequences:

| | |
|---|--|
| MATH UN1101 - MATH UN1102 - MATH UN1201 - MATH UN2010 - MATH UN2500 | CALCULUS I and CALCULUS II and Calculus III and LINEAR ALGEBRA and ANALYSIS AND OPTIMIZATION |
| MATH UN1207 - MATH UN1208 - MATH UN2500 | Honors Mathematics A and HONORS MATHEMATICS B and ANALYSIS AND OPTIMIZATION |

Statistics

Statistics required courses

| | |
|-------------|---|
| STAT UN1201 | Calculus-Based Introduction to Statistics |
| STAT GU4203 | PROBABILITY THEORY |

| | |
|-------------|--------------------------|
| STAT GU4204 | Statistical Inference |
| STAT GU4205 | Linear Regression Models |

And select one of the following courses:

| | |
|-------------|----------------------------------|
| STAT GU4207 | Elementary Stochastic Processes |
| STAT GU4262 | Stochastic Processes for Finance |
| STAT GU4264 | STOCHASTIC PROCESSES-APPLIC |
| 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 |
| COMS W1007 | Honors Introduction to Computer Science |
| ENGI E1006 | Introduction to Computing for Engineers and Applied Scientists |

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.

Students should plan to include a senior thesis or the Undergraduate Seminar in Mathematics in their program, in consultation with their advisors.

Note: Students must obtain approval from an adviser in each of the two departments before selecting electives. Students should take MATH UN2010 LINEAR ALGEBRA in the second semester of the second year.

For a major in Mathematics-Computer Science 15 courses (a minimum of 38 credits):

Mathematics

Four courses in calculus or Honors Mathematics A-B, including Advanced Placement Credit; and the 3 following courses:

| | |
|----------------|---|
| MATH UN2010 | LINEAR ALGEBRA (also satisfied by Honors Math A-B) |
| MATH GU4041 | INTRO MODERN ALGEBRA I |
| MATH UN3951 | Undergraduate Seminars in Mathematics I (at least one term) |
| or MATH UN3952 | Undergraduate Seminars in Mathematics II |

Computer Science

| | |
|------------|--|
| COMS W1004 | Introduction to Computer Science and Programming in Java |
| COMS W3134 | Data Structures in Java |
| COMS W3157 | Advanced Programming |
| COMS W3203 | DISCRETE MATHEMATICS |
| COMS W3261 | Computer Science Theory |
| CSEE W3827 | Fundamentals of Computer Systems |

Note A: AP Computer Science with a grade of 4 or 5 or similar experience (e.g., COMS W1004) is a prerequisite for COMS W1007

Electives: 2 of the following:

| | |
|-------------|-------------------------------------|
| CSOR W4231 | Analysis of Algorithms I |
| COMS W4241 | Numerical Algorithms and Complexity |
| MATH UN3020 | Number Theory and Cryptography |

| | |
|-------------|---------------------------|
| MATH BC2006 | Combinatorics |
| MATH GU4061 | INTRO MODERN ANALYSIS I |
| MATH UN2500 | ANALYSIS AND OPTIMIZATION |
| MATH UN3007 | Complex Variables |
| MATH UN3386 | Differential Geometry |
| MATH GU4051 | Topology |

Students seeking to pursue a Ph.D. program in either discipline are urged to take additional courses, in consultation with their advisers.

For a major in Economics and Mathematics, see the catalogue.

Requirement for the Minor in Mathematics

For a minor in Mathematics or Applied Mathematics: Six courses from any of the courses offered by the department except MATH UN1003 COLLEGE ALGEBRA-ANLYTC GEOMETRY, MATH UN1101 CALCULUS I / MATH UN1102 CALCULUS II. Some cognate courses are also acceptable with prior approval from the department chair.

Requirements for the Minor in Mathematical Sciences

The minor in Mathematical Sciences comprises 6 courses, at least two from Mathematics and one from each of Statistics and Computer Science. There should be a minimum of three courses in Statistics and Computer Science. Eligible courses are any listed in the Mathematical Sciences Major with the exception of Calculus I and II.

MATH UN1003 COLLEGE ALGEBRA-ANLYTC GEOMETRY. 3.00 points.

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

| Spring 2021: MATH UN1003 | | | | | |
|--------------------------|---------------------|---|------------------|--------|------------|
| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
| MATH 1003 | 001/12309 | M W 1:10pm - 2:25pm Online Only | Nguyen Dung | 3.00 | 14/35 |
| MATH 1003 | 002/12310 | T Th 6:10pm - 7:25pm Online Only | Shalin Parekh | 3.00 | 20/35 |
| MATH 1003 | AU1/19220 | | Nguyen Dung | 3.00 | 1/5 |
| Fall 2021: MATH UN1003 | | | | | |
| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
| MATH 1003 | 001/10617 | M W 6:10pm - 7:25pm 407 Mathematics Building | Emily Saunders | 3.00 | 24/30 |
| MATH 1003 | 004/00826 | T Th 2:40pm - 3:55pm 324 Milbank Hall | Lindsay Piechnik | 3.00 | 27/30 |

MATH UN1101 CALCULUS I. 3.00 points.

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

Spring 2021: MATH UN1101

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---------------------------------------|-------------------------|--------|------------|
| MATH 1101 | 001/12308 | M W 2:40pm - 3:55pm Online Only | Sayan Das | 3.00 | 13/35 |
| MATH 1101 | 002/12307 | M W 4:10pm - 5:25pm Online Only | Kevin Smith | 3.00 | 31/35 |
| MATH 1101 | 003/12306 | T Th 10:10am - 11:25am Online Only | Panagiota Daskalopoulos | 3.00 | 61/100 |
| MATH 1101 | 004/12305 | T Th 11:40am - 12:55pm Online Only | George Dragomir | 3.00 | 82/100 |
| MATH 1101 | 005/12304 | T Th 4:10pm - 5:25pm Online Only | Tobias Schaefer | 3.00 | 20/40 |
| MATH 1101 | AU1/19222 | | Sayan Das | 3.00 | 1/5 |

Fall 2021: MATH UN1101

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|----------------------|--------|------------|
| MATH 1101 | 001/10622 | M W 10:10am - 11:25am 203 Mathematics Building | Daniele Alessandrini | 3.00 | 68/100 |
| MATH 1101 | 002/10623 | M W 1:10pm - 2:25pm 203 Mathematics Building | Amadou Bah | 3.00 | 42/64 |
| MATH 1101 | 003/10624 | M W 2:40pm - 3:55pm 203 Mathematics Building | Akash Sengupta | 3.00 | 110/110 |
| MATH 1101 | 004/10625 | M W 4:10pm - 5:25pm 203 Mathematics Building | Akash Sengupta | 3.00 | 109/110 |
| MATH 1101 | 005/10626 | T Th 10:10am - 11:25am 312 Mathematics Building | George Dragomir | 3.00 | 100/116 |
| MATH 1101 | 006/10628 | T Th 11:40am - 12:55pm 203 Mathematics Building | George Dragomir | 3.00 | 86/110 |
| MATH 1101 | 007/00170 | M W 6:10pm - 7:25pm 405 Milbank Hall | Lindsay Piechnik | 3.00 | 99/100 |
| MATH 1101 | 008/10629 | T Th 1:10pm - 2:25pm 417 Mathematics Building | Xi Shen | 3.00 | 49/64 |
| MATH 1101 | 009/10630 | T Th 4:10pm - 5:25pm 407 Mathematics Building | Xi Shen | 3.00 | 28/35 |
| MATH 1101 | 011/00171 | T Th 2:40pm - 3:55pm 302 Barnard Hall | | 3.00 | 0/100 |
| MATH 1101 | 012/20205 | T Th 2:40pm - 3:55pm 517 Hamilton Hall | Mrudul Thatte | 3.00 | 25/30 |

MATH UN1102 CALCULUS II. 3.00 points.

Prerequisites: MATH UN1101 or the equivalent.

Prerequisites: MATH UN1101 or the equivalent. Methods of integration, applications of the integral, Taylors theorem, infinite series. (SC)

Spring 2021: MATH UN1102

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---------------------------------------|---------------------|--------|------------|
| MATH 1102 | 001/12303 | M W 11:40am - 12:55pm Online Only | Maithreya Sitaraman | 3.00 | 12/35 |
| MATH 1102 | 002/12302 | M W 4:10pm - 5:25pm Online Only | Yier Lin | 3.00 | 14/35 |
| MATH 1102 | 003/12301 | T Th 11:40am - 12:55pm Online Only | Evgeni Dimitrov | 3.00 | 73/100 |
| MATH 1102 | 004/12300 | T Th 1:10pm - 2:25pm Online Only | Evgeni Dimitrov | 3.00 | 53/100 |
| MATH 1102 | AU1/19280 | | Maithreya Sitaraman | 3.00 | 1/5 |

Fall 2021: MATH UN1102

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|--------------------|--------|------------|
| MATH 1102 | 001/10631 | M W 1:10pm - 2:25pm 407 Mathematics Building | Gerhardt Hinkle | 3.00 | 21/35 |
| MATH 1102 | 002/10632 | M W 2:40pm - 3:55pm 407 Mathematics Building | Yash Uday Deshmukh | 3.00 | 23/35 |
| MATH 1102 | 003/10634 | M W 4:10pm - 5:25pm 312 Mathematics Building | Francesco Lin | 3.00 | 99/116 |
| MATH 1102 | 004/10635 | T Th 10:10am - 11:25am 203 Mathematics Building | Dobrin Marchev | 3.00 | 64/100 |
| MATH 1102 | 005/10636 | T Th 11:40am - 12:55pm 614 Schermerhorn Hall | Yu-sheng Lee | 3.00 | 34/35 |
| MATH 1102 | 006/10638 | T Th 6:10pm - 7:25pm 520 Mathematics Building | Elliott Stein | 3.00 | 44/49 |

MATH UN1201 Calculus III. 3 points.

Prerequisites: MATH UN1101 or the equivalent

Vectors in dimensions 2 and 3, complex numbers and the complex exponential function with applications to differential equations, Cramer's 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 2021: MATH UN1201

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--------------------------------------|------------------|--------|------------|
| MATH 1201 | 001/12299 | M W 10:10am - 11:25am Online Only | Nicholas Salter | 3 | 59/100 |
| MATH 1201 | 002/12298 | M W 11:40am - 12:55pm Online Only | Nicholas Salter | 3 | 80/100 |
| MATH 1201 | 003/12297 | M W 1:10pm - 2:25pm Online Only | Mu-Tao Wang | 3 | 13/100 |
| MATH 1201 | 004/12296 | T Th 2:40pm - 3:55pm Online Only | Andrew Ahn | 3 | 52/100 |
| MATH 1201 | 005/00082 | T Th 4:10pm - 5:25pm Room TBA | Lindsay Piechnik | 3 | 93/100 |
| MATH 1201 | 006/00083 | T Th 6:10pm - 7:25pm Room TBA | Lindsay Piechnik | 3 | 82/100 |
| MATH 1201 | AU4/19228 | | Andrew Ahn | 3 | 1/5 |

Fall 2021: MATH UN1201

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|---------------------|--------|------------|
| MATH 1201 | 001/10640 | M W 10:10am - 11:25am 312 Mathematics Building | Konstantin Aleshkin | 3 | 30/100 |
| MATH 1201 | 002/10641 | M W 11:40am - 12:55pm 203 Mathematics Building | Konstantin Aleshkin | 3 | 31/100 |
| MATH 1201 | 003/10642 | M W 1:10pm - 2:25pm 207 Mathematics Building | Tudor Padurariu | 3 | 31/100 |
| MATH 1201 | 004/10645 | M W 2:40pm - 3:55pm 312 Mathematics Building | Tudor Padurariu | 3 | 29/100 |
| MATH 1201 | 005/10646 | T Th 11:40am - 12:55pm 207 Mathematics Building | Chen-Chih Lai | 3 | 38/100 |
| MATH 1201 | 006/10647 | T Th 1:10pm - 2:25pm 203 Mathematics Building | Stephen Miller | 3 | 81/100 |
| MATH 1201 | 007/10648 | T Th 2:40pm - 3:55pm 207 Mathematics Building | Inbar Klang | 3 | 102/100 |
| MATH 1201 | 008/10649 | T Th 4:10pm - 5:25pm 207 Mathematics Building | Inbar Klang | 3 | 100/100 |

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 2021: MATH UN1202

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|------------------------------------|------------------|--------|------------|
| MATH 1202 | 001/00084 | T Th 10:10am - 11:25am Room TBA | Daniela De Silva | 3.00 | 41/100 |
| MATH 1202 | 002/00085 | T Th 1:10pm - 2:25pm Room TBA | Daniela De Silva | 3.00 | 46/100 |
| MATH 1202 | AU2/19283 | | Daniela De Silva | 3.00 | 1/5 |

Fall 2021: MATH UN1202

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---|-----------------|--------|------------|
| MATH 1202 | 001/10650 | M W 1:10pm - 2:25pm 417 Mathematics Building | Mu-Tao Wang | 3.00 | 26/100 |
| MATH 1202 | 002/10651 | M W 6:10pm - 7:25pm 207 Mathematics Building | Mikhail Smirnov | 3.00 | 48/100 |

MATH UN1207 Honors Mathematics A. 4 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 2021: MATH UN1207

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|-------------|--------|------------|
| MATH 1207 | 001/10656 | T Th 1:10pm - 2:25pm 207 Mathematics Building | Evan Warner | 4 | 55/100 |

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 2021: MATH UN1208

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|-------------------------------------|-------------|--------|------------|
| MATH 1208 | 001/12294 | T Th 1:10pm - 2:25pm Online Only | Evan Warner | 4.00 | 41/100 |

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 2021: MATH UN2000

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--------------------------------------|--------------|--------|------------|
| MATH 2000 | 001/12293 | M W 10:10am - 11:25am Online Only | Gus Schrader | 3.00 | 28/100 |

Fall 2021: MATH UN2000

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---|-------------|--------|------------|
| MATH 2000 | 001/00172 | M W 10:10am - 11:25am 302 Milbank Hall | Dusa McDuff | 3.00 | 36/55 |

MATH BC2001 Perspectives in Mathematics. 1 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.

MATH BC2006 Combinatorics. 3 points.

Corequisites: *MATH V2010* is helpful as a corequisite, but not required. Honors-level introductory course in enumerative combinatorics. Pigeonhole principle, binomial coefficients, permutations and combinations. Polya enumeration, inclusion-exclusion principle, generating functions and recurrence relations.

Spring 2021: MATH BC2006

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|------------------------------------|-------------|--------|------------|
| MATH 2006 | 001/00086 | T Th 10:10am - 11:25am Room TBA | David Bayer | 3 | 38/40 |

MATH UN2010 LINEAR ALGEBRA. 3.00 points.

Prerequisites: MATH UN1201 or the equivalent. Prerequisites: MATH UN1201 or the equivalent. Matrices, vector spaces, linear transformations, eigenvalues and eigenvectors, canonical forms, applications. (SC)

Spring 2021: MATH UN2010

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---------------------------------------|---------------------|--------|------------|
| MATH 2010 | 001/12292 | M W 10:10am - 11:25am Online Only | Konstantin Aleshkin | 3.00 | 21/100 |
| MATH 2010 | 002/12291 | M W 1:10pm - 2:25pm Online Only | Gus Schrader | 3.00 | 83/120 |
| MATH 2010 | 003/12290 | T Th 11:40am - 12:55pm Online Only | Stephen Miller | 3.00 | 73/100 |
| MATH 2010 | 004/12289 | T Th 1:10pm - 2:25pm Online Only | Andrew Ahn | 3.00 | 19/100 |
| MATH 2010 | 005/12288 | T Th 6:10pm - 7:25pm Online Only | Elliott Stein | 3.00 | 28/45 |
| MATH 2010 | AU4/19231 | | Andrew Ahn | 3.00 | 1/5 |

Fall 2021: MATH UN2010

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---|------------------|--------|------------|
| MATH 2010 | 001/00173 | T Th 8:40am - 9:55am 328 Milbank Hall | David Bayer | 3.00 | 32/50 |
| MATH 2010 | 002/00174 | T Th 10:10am - 11:25am 328 Milbank Hall | David Bayer | 3.00 | 45/50 |
| MATH 2010 | 003/10679 | M W 10:10am - 11:25am 207 Mathematics Building | Marco Castronovo | 3.00 | 38/100 |
| MATH 2010 | 004/10693 | M W 11:40am - 12:55pm 312 Mathematics Building | Marco Castronovo | 3.00 | 48/100 |
| MATH 2010 | 005/10698 | T Th 4:10pm - 5:25pm 520 Mathematics Building | Henry Pinkham | 3.00 | 15/49 |

MATH UN2020 Honors Linear Algebra. 3 points.

Not offered during 2021-22 academic year.

Prerequisites: MATH UN1201. A more extensive treatment of the material in MATH UN2010, with increased emphasis on proof. Not to be taken in addition to MATH UN2010 or MATH UN1207-MATH UN1208.

MATH UN2030 ORDINARY DIFFERENTIAL EQUATION. 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 2021: MATH UN2030

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---------------------------------------|-----------------|--------|------------|
| MATH 2030 | 001/12287 | M W 2:40pm - 3:55pm Online Only | Igor Krichever | 3.00 | 63/100 |
| MATH 2030 | 002/12286 | T Th 10:10am - 11:25am Online Only | Aleksander Doan | 3.00 | 47/100 |

Fall 2021: MATH UN2030

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|-----------------|--------|------------|
| MATH 2030 | 001/10718 | M W 1:10pm - 2:25pm 312 Mathematics Building | Florian Johne | 3.00 | 39/100 |
| MATH 2030 | 002/10719 | T Th 2:40pm - 3:55pm 312 Mathematics Building | Evgeni Dimitrov | 3.00 | 69/100 |

MATH UN2500 ANALYSIS AND OPTIMIZATION. 3.00 points.

Prerequisites: MATH UN1102 and MATH UN1201 or the equivalent and MATH UN2010.

Prerequisites: MATH UN1102 and MATH UN1201 or the equivalent and MATH UN2010. 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 2021: MATH UN2500

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|------------------------------------|--------------|--------|------------|
| MATH 2500 | 001/12285 | M W 1:10pm - 2:25pm Online Only | Yash Jhaveri | 3.00 | 52/100 |
| MATH 2500 | 002/12284 | M W 2:40pm - 3:55pm Online Only | Yash Jhaveri | 3.00 | 40/100 |

Fall 2021: MATH UN2500

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|----------------------|--------|------------|
| MATH 2500 | 001/10720 | T Th 10:10am - 11:25am 417 Mathematics Building | Kanstantsin Matetski | 3.00 | 37/64 |
| MATH 2500 | 002/10721 | T Th 11:40am - 12:55pm 417 Mathematics Building | Kanstantsin Matetski | 3.00 | 58/64 |

MATH UN3007 Complex Variables. 3 points.

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 2021: MATH UN3007

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---|--------------|--------|------------|
| MATH 3007 | 001/10722 | M W 2:40pm - 3:55pm 417 Mathematics Building | Ovidiu Savin | 3 | 41/64 |

MATH UN3020 Number Theory and Cryptography. 3 points.

Prerequisites: one year of calculus.

Prerequisite: One year of Calculus. Congruences. Primitive roots. Quadratic residues. Contemporary applications.

MATH UN3025 Making, Breaking Codes. 3 points.

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.

Fall 2021: MATH UN3025

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|-----------------|--------|------------|
| MATH 3025 | 001/10723 | T Th 1:10pm - 2:25pm 312 Mathematics Building | Dorian Goldfeld | 3 | 99/100 |

MATH UN3027 Ordinary Differential Equations. 3 points.

Prerequisites: MATH UN1102 and MATH UN1201 or the equivalent.

Corequisites: MATH UN2010

Equations of order one; systems of linear equations. Second-order equations. Series solutions at regular and singular points. Boundary value problems. Selected applications.

Fall 2021: MATH UN3027

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|--------------|--------|------------|
| MATH 3027 | 001/10735 | T Th 11:40am - 12:55pm 312 Mathematics Building | Elena Giorgi | 3 | 42/100 |

MATH UN3028 PARTIAL DIFFERENTIAL EQUATIONS. 3.00 points.

Prerequisites: MATH UN3027 and MATH UN2010 or the equivalent

Prerequisites: MATH UN3027 and MATH UN2010 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 2021: MATH UN3028

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|------------------------------------|---------------|--------|------------|
| MATH 3028 | 001/12282 | M W 1:10pm - 2:25pm Online Only | Florian Johne | 3.00 | 45/100 |

MATH UN3050 Discrete Time Models in Finance. 3 points.

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

Spring 2021: MATH UN3050

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---|-----------------|--------|------------|
| MATH 3050 | 001/13870 | M W 6:10pm - 7:25pm 312 Mathematics Building | Mikhail Smirnov | 3 | 55/60 |

MATH UN3386 Differential Geometry. 3 points.

Prerequisites: MATH UN1202 or the equivalent.

Local and global differential geometry of submanifolds of Euclidean 3-space. Frenet formulas for curves. Various types of curvatures for curves and surfaces and their relations. The Gauss-Bonnet theorem.

Fall 2021: MATH UN3386

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|------------------|--------|------------|
| MATH 3386 | 001/10751 | T Th 11:40am - 12:55pm 520 Mathematics Building | Richard Hamilton | 3 | 9/49 |

MATH UN3901 Supervised Readings in Mathematics I. 2-3 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 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.

MATH UN3902 Supervised Readings in Mathematics II. 2-3 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 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.

Spring 2021: MATH UN3902

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|----------------|-------------------------|--------|------------|
| MATH 3902 | 001/17763 | | Dusa McDuff | 2-3 | 1/1 |
| MATH 3902 | 002/17765 | | Francesco Lin | 2-3 | 1/1 |
| MATH 3902 | 003/19327 | | Dorian Goldfeld | 2-3 | 1/1 |
| MATH 3902 | 004/19328 | | Guillaume Remy | 2-3 | 1/1 |
| MATH 3902 | 005/19366 | | Ivan Corwin | 2-3 | 2/2 |
| MATH 3902 | 006/19925 | | Ioannis Karatzas | 2-3 | 2/6 |
| MATH 3902 | 007/19928 | | Stephen Miller | 2-3 | 2/3 |
| MATH 3902 | 008/20024 | | Panagiota Daskalopoulos | 2-3 | 1/1 |
| MATH 3902 | 009/20193 | | Stephen Miller | 2-3 | 1/4 |
| MATH 3902 | 010/20245 | | Evan Warner | 2-3 | 3/4 |
| MATH 3902 | 011/20347 | | Giulia Sacca | 2-3 | 1/1 |
| MATH 3902 | 012/20356 | | Peter Voit | 2-3 | 1/1 |
| MATH 3902 | 013/20358 | | Stephen Miller | 2-3 | 1/1 |
| MATH 3902 | 015/20480 | | Mikhail Khovanov | 2-3 | 1/1 |

Fall 2021: MATH UN3902

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|----------------|----------------|--------|------------|
| MATH 3902 | 001/13725 | | Dusa McDuff | 2-3 | 1/1 |
| MATH 3902 | 002/18860 | | Florian Johne | 2-3 | 2/2 |
| MATH 3902 | 003/20170 | | Dusa McDuff | 2-3 | 1/1 |
| MATH 3902 | 004/20293 | | Akash Sengupta | 2-3 | 1/1 |
| MATH 3902 | 005/20556 | | Ovidiu Savin | 2-3 | 1/1 |
| MATH 3902 | 006/20296 | | Simon Brendle | 2-3 | 1/1 |
| MATH 3902 | 007/20649 | | Chao Li | 2-3 | 1/2 |

MATH UN3951 Undergraduate Seminars in Mathematics I. 3 points.

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 2021: MATH UN3951

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|----------------|------------------|--------|------------|
| MATH 3951 | 001/00175 | | Daniela De Silva | 3 | 61/64 |

MATH UN3952 Undergraduate Seminars in Mathematics II. 3 points.

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 2021: MATH UN3952

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|----------------|-------------|--------|------------|
| MATH 3952 | 001/00688 | | David Bayer | 3 | 41/60 |

MATH UN3997 Supervised Individual Research. 3 points.

Prerequisites: The written permission of the faculty member who agrees to act as a supervisor, and the permission of the Director of Undergraduate Studies. For specially selected mathematics majors, the opportunity to write a senior thesis on a problem in contemporary mathematics under the supervision of a faculty member.

Spring 2021: MATH UN3997

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|----------------|-------------|--------|------------|
| MATH 3997 | 001/00749 | | David Bayer | 3 | 1/1 |

MATH UN3998 Supervised Individual Research. 3 points.

Prerequisites: The written permission of the faculty member who agrees to act as a supervisor, and the permission of the Director of Undergraduate Studies. For specially selected mathematics majors, the opportunity to write a senior thesis on a problem in contemporary mathematics under the supervision of a faculty member.

MATH GU4007 Analytic Number Theory. 3 points.

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, $SL(2, \mathbb{Z})$ 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 2021: MATH GU4007

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---------------------------------------|-----------------|--------|------------|
| MATH 4007 | 001/12281 | T Th 11:40am - 12:55pm Online Only | Dorian Goldfeld | 3 | 13/50 |

MATH GU4032 Fourier Analysis. 3 points.

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.

Fall 2021: MATH GU4032

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---|---------------|--------|------------|
| MATH 4032 | 001/10764 | M W 10:10am - 11:25am 520 Mathematics Building | Simon Brendle | 3 | 19/49 |

MATH GU4041 INTRO MODERN ALGEBRA I. 3 points.

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, rings, ideals, fields, polynomials, field extensions, Galois theory.

Spring 2021: MATH GU4041

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--------------------------------------|----------------------|--------|------------|
| MATH 4041 | 001/12280 | M W 10:10am - 11:25am Online Only | Daniele Alessandrini | 3 | 35/100 |
| MATH 4041 | AU1/19290 | | Daniele Alessandrini | 3 | 2/5 |

Fall 2021: MATH GU4041

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---|-----------------|--------|------------|
| MATH 4041 | 001/12812 | M W 2:40pm - 3:55pm 207 Mathematics Building | Robert Friedman | 3 | 67/100 |

MATH GU4042 INTRO MODERN ALGEBRA II. 3 points.

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 2021: MATH GU4042

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|------------------------------------|-------------|--------|------------|
| MATH 4042 | 001/12279 | M W 2:40pm - 3:55pm Online Only | Inbar Klang | 3 | 42/100 |
| MATH 4042 | AU1/19291 | | Inbar Klang | 3 | 1/5 |

Fall 2021: MATH GU4042

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|---------------|--------|------------|
| MATH 4042 | 001/10765 | T Th 2:40pm - 3:55pm 417 Mathematics Building | William Sawin | 3 | 9/64 |

MATH GU4043 Algebraic Number Theory. 3 points.

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.

MATH GU4044 Representations of Finite Groups. 3 points.

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 2021: MATH GU4044

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|------------|--------|------------|
| MATH 4044 | 001/10766 | T Th 1:10pm - 2:25pm 407 Mathematics Building | Chao Li | 3 | 9/35 |

MATH GU4045 Algebraic Curves. 3 points.

Prerequisites: (MATH GU4041 and MATH GU4042) and MATH UN3007 Plane curves, affine and projective varieties, singularities, normalization, Riemann surfaces, divisors, linear systems, Riemann-Roch theorem.

MATH W4046 Introduction to Category Theory. 3 points.

CC/GS: Partial Fulfillment of Science Requirement
Not offered during 2021-22 academic year.

Prerequisites: *MATH W4041*.

Categories, functors, natural transformations, adjoint functors, limits and colimits, introduction to higher categories and diagrammatic methods in algebra.

MATH GU4051 Topology. 3 points.

Prerequisites: (MATH UN1202 and MATH UN2010) and rudiments of group theory (e.g., MATH GU4041). MATH UN1208 or MATH GU4061 is recommended, but not required.

Metric spaces, continuity, compactness, quotient spaces. The fundamental group of topological space. Examples from knot theory and surfaces. Covering spaces.

Fall 2021: MATH GU4051

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|----------------|--------|------------|
| MATH 4051 | 001/10767 | T Th 2:40pm - 3:55pm 520 Mathematics Building | Stephen Miller | 3 | 31/49 |

MATH GU4052 Introduction to Knot Theory. 3 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 \mathbb{R}^3 , including but not limited to knot projections and Reidemeister's 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 2021: MATH GU4052

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---|-------------|--------|------------|
| MATH 4052 | 001/10768 | M W 1:10pm - 2:25pm 307 Mathematics Building | Kyle Hayden | 3 | 11/19 |

MATH GU4053 Introduction to Algebraic Topology. 3 points.

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

MATH GU4061 INTRO MODERN ANALYSIS I. 3 points.

Prerequisites: MATH UN1202 or the equivalent, and MATH UN2010. The second term of this course may not be taken without the first.

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

Spring 2021: MATH GU4061

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|------------------------------------|------------|--------|------------|
| MATH 4061 | 001/12278 | M W 1:10pm - 2:25pm Online Only | Hui Yu | 3 | 39/100 |
| MATH 4061 | 002/12277 | M W 4:10pm - 5:25pm Online Only | Hui Yu | 3 | 30/100 |

Fall 2021: MATH GU4061

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|-----------------------|--------|------------|
| MATH 4061 | 001/10769 | T Th 2:40pm - 3:55pm 203 Mathematics Building | Abhijit Champanerker | 3 | 35/100 |
| MATH 4061 | 002/10770 | T Th 4:10pm - 5:25pm 203 Mathematics Building | Jorge Pineiro Barcelo | 3 | 39/100 |

MATH GU4062 INTRO MODERN ANALYSIS II. 3.00 points.

Prerequisites: MATH UN1202 or the equivalent, and MATH UN2010. The second term of this course may not be taken without the first.

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

Spring 2021: MATH GU4062

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|-------------------------------------|--------------|--------|------------|
| MATH 4062 | 001/12276 | T Th 4:10pm - 5:25pm Online Only | Henri Roesch | 3.00 | 20/100 |

Fall 2021: MATH GU4062

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|---|--------------|--------|------------|
| MATH 4062 | 001/10771 | M W 4:10pm - 5:25pm 417 Mathematics Building | Yash Jhaveri | 3.00 | 13/64 |

MATH GU4065 Honors Complex Variables. 3 points.

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 GU4071 Introduction to the Mathematics of Finance. 3 points.

CC/GS: Partial Fulfillment of Science Requirement

Prerequisites: MATH UN1202 and MATH UN3027 and STAT W4150 and SEIO W4150, or their equivalents.

The mathematics of finance, principally the problem of pricing of derivative securities, developed using only calculus and basic probability. Topics include mathematical models for financial instruments, Brownian motion, normal and lognormal distributions, the Black-Scholes formula, and binomial models.

MATH GU4081 Introduction to Differentiable Manifolds. 3 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. Intersection theory. Orientations. Poincaré-Hopf theorem. Differential forms and Stokes' theorem.

Spring 2021: MATH GU4081

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|-----------------------------------|-------------|--------|------------|
| MATH 4081 | 001/00088 | M W 10:10am - 11:25am Room TBA | Dusa McDuff | 3 | 15/40 |

MATH GU4155 Probability Theory. 3 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 2021: MATH GU4155

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|-------------------------------------|------------------|--------|------------|
| MATH 4155 | 001/12275 | T Th 2:40pm - 3:55pm Online Only | Ioannis Karatzas | 3 | 13/55 |

MATH GU4392 INTRO TO QUANTUM MECHANICS II. 3.00 points.

Not offered during 2021-22 academic year.

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

Spring 2021: MATH GU4392

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|-------------------------------------|------------|--------|------------|
| MATH 4392 | 001/12274 | T Th 4:10pm - 5:25pm Online Only | Peter Woit | 3.00 | 4/40 |

Cross-Listed Courses

Computer Science

COMS S3251 Computational Linear Algebra. 3 points.

Not offered during 2021-22 academic year.

Prerequisites: two terms of calculus.

Computational linear algebra, solution of linear systems, sparse linear systems, least squares, eigenvalue problems, and numerical solution of other multivariate problems as time permits.

COMS W4203 Graph Theory. 3 points.

Lect: 3.

Prerequisites: (COMS W3203)

General introduction to graph theory. Isomorphism testing, algebraic specification, symmetries, spanning trees, traversability, planarity, drawings on higher-order surfaces, colorings, extremal graphs, random graphs, graphical measurement, directed graphs, Burnside-Polya counting, voltage graph theory.

COMS W3203 DISCRETE MATHEMATICS. 4.00 points.

Lect: 3.

Prerequisites: Any introductory course in computer programming.

Prerequisites: Any introductory course in computer programming. Logic and formal proofs, sequences and summation, mathematical induction, binomial coefficients, elements of finite probability, recurrence relations, equivalence relations and partial orderings, and topics in graph theory (including isomorphism, traversability, planarity, and colorings)

Spring 2021: COMS W3203

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--------------------------------------|----------------------|--------|------------|
| COMS 3203 | 001/13030 | M W 10:10am - 11:25am Online Only | Ansaf Salleb-Aouissi | 4.00 | 159/165 |

Fall 2021: COMS W3203

| Course Number | Section/Call Number | Times/Location | Instructor | Points | Enrollment |
|---------------|---------------------|--|-------------------|--------|------------|
| COMS 3203 | 001/12483 | M W 4:10pm - 5:25pm 833 Seeley W. Mudd Building | Yining Liu | 4.00 | 117/120 |
| COMS 3203 | 002/12484 | T Th 5:40pm - 6:55pm 207 Mathematics Building | Antonio Moretti | 4.00 | 128/150 |
| COMS 3203 | 003/20412 | F 10:10am - 12:40pm 402 Chandler | Daniel Rubenstein | 4.00 | 50/120 |

Industrial Engineering and Operations Research**CSOR E4010 Graph Theory: A Combinatorial View. 3 points.**Lect: 3. **Not offered during 2021-22 academic year.**

Prerequisites: Linear Algebra, or instructor's permission.

Graph Theory is an important part of the theoretical basis of operations research. A good understanding of the basic fundamentals of graph theory is necessary in order to apply the theory successfully in the future. This is an introductory course in graph theory with emphasis on its combinatorial aspects. It covers basic definitions, and some fundamental concepts in graph theory and its applications. Topics include trees and forests graph coloring, connectivity, matching theory and others. This course will provide a solid foundation for students in the IEOR department, on which further courses may build.