Mathematics

The Department of Mathematics offers both a terminal MA program and a PhD program in Mathematics.

Students are admitted for specific degree programs: the MA in Mathematics, PhD in Mathematics, or PhD in Applied Mathematics. Requirements for the Mathematics and Applied Mathematics PhDs differ only in minor respects, and no distinction is made between the two in day-to-day matters.

Continuing students wishing to transfer from one program to another should consult the graduate assistant in 910 Evans Hall. Transfers between the two PhD programs and from the PhD program to the MA program are fairly routine but should be done prior to taking the qualifying exam. Applications to transfer from the MA to the PhD program are reviewed carefully. It is a formal policy of the department that an applicant to the PhD program who has previous graduate work in mathematics—including our own MA program—must present very strong evidence of capability for mathematical research.

While MA degrees are awarded, in recent years few MA students have been admitted from outside the university. A small number of pre-PhD students have been admitted. These are promising candidates whose preparation is not yet sufficient for PhD study, and who are initially admitted for the MA degrees. The progress of pre-PhD students is reviewed late in the spring semester. Those deemed prepared are eligible to advance to the PhD program, by completing a routine Petition to Change Program, obtainable from the graduate assistant. Completion of the requirements for the MA is not required.

Students seeking to transfer to the Mathematics MA or PhD programs from other campus programs, including the Group in Logic and the Methodology of Science, must formally apply and should consult the graduate vice chair.

Admission to the University

Minimum Requirements for Admission

The following minimum requirements apply to all graduate programs and will be verified by the Graduate Division:

1. A bachelor's degree or recognized equivalent from an accredited institution;
2. A grade point average of B or better (3.0);
3. If the applicant comes from a country or political entity (e.g., Quebec) where English is not the official language, adequate proficiency in English to do graduate work, as evidenced by a TOEFL score of at least 90 on the iBT test, 570 on the paper-and-pencil test, or an IELTS Band score of at least 7 (note that individual programs may set higher levels for any of these); and
4. Sufficient undergraduate training to do graduate work in the given field.

Applicants Who Already Hold a Graduate Degree

The Graduate Council views academic degrees not as vocational training certificates, but as evidence of broad training in research methods, independent study, and articulation of learning. Therefore, applicants who already have academic graduate degrees should be able to pursue new subject matter at an advanced level without need to enroll in a related or similar graduate program.

Programs may consider students for an additional academic master's or professional master's degree only if the additional degree is in a distinctly different field.

Applicants admitted to a doctoral program that requires a master's degree to be earned at Berkeley as a prerequisite (even though the applicant already has a master's degree from another institution in the same or a closely allied field of study) will be permitted to undertake the second master's degree, despite the overlap in field.

The Graduate Division will admit students for a second doctoral degree only if they meet the following guidelines:

1. Applicants with doctoral degrees may be admitted for an additional doctoral degree only if that degree program is in a general area of knowledge distinctly different from the field in which they earned their original degree. For example, a physics PhD could be admitted to a doctoral degree program in music or history; however, a student with a doctoral degree in mathematics would not be permitted to add a PhD in statistics.
2. Applicants who hold the PhD degree may be admitted to a professional doctorate or professional master's degree program if there is no duplication of training involved.

Applicants may apply only to one single degree program or one concurrent degree program per admission cycle.

Required Documents for Applications

1. **Transcripts:** Applicants may upload *unofficial* transcripts with your application for the departmental initial review. *If the applicant is admitted,* then *official* transcripts of all college-level work will be required. Official transcripts must be in sealed envelopes as issued by the school(s) attended. If you have attended Berkeley, upload your unofficial transcript with your application for the departmental initial review. *If you are admitted,* an official transcript with evidence of degree conferral *will not* be required.
2. **Letters of recommendation:** Applicants may request online letters of recommendation through the online application system. Hard copies of recommendation letters must be sent directly to the program, not the Graduate Division.
3. **Evidence of English language proficiency:** All applicants from countries or political entities in which the official language is not English are required to submit official evidence of English language proficiency. This applies to applicants from Bangladesh, Burma, Nepal, India, Pakistan, Latin America, the Middle East, the People's Republic of China, Taiwan, Japan, Korea, Southeast Asia, most European countries, and Quebec (Canada). However, applicants who, at the time of application, have already completed at least one year of full-time academic course work with grades of B or better at a US university may submit an official transcript from the US university to fulfill this requirement. The following courses will not fulfill this requirement:
    - courses in English as a Second Language,
    - courses conducted in a language other than English,
    - courses that will be completed after the application is submitted, and
    - courses of a non-academic nature.

If applicants have previously been denied admission to Berkeley on the basis of their English language proficiency, they must submit new test scores that meet the current minimum from one of the standardized tests.

Where to Apply

Visit the Berkeley Graduate Division application page (http://grad.berkeley.edu/admissions/apply) .

Admission to the Program

Students preparing for the PhD in mathematics are strongly advised to acquire a reading knowledge of one foreign language from among French, German, and Russian.

Undergraduate students also often take one or more of the following introductory Mathematics graduate courses:

MATH 202A	Introduction to Topology and Analysis	4
MATH 202B	Introduction to Topology and Analysis	4
MATH 214	Differentiable Manifolds	4
MATH 225A	Metamathematics	4
MATH 225B	Metamathematics	4
MATH 228A	Numerical Solution of Differential Equations	4
MATH 228B	Numerical Solution of Differential Equations	4
MATH 250A	Groups, Rings, and Fields	4
MATH 250B	Multilinear Algebra and Further Topics	4

The Math Department admits new graduate students to the fall semester only. The Graduate Division's Online Application will be available in early September here (http://grad.berkeley.edu/admissions/apply) . Please read the information on Graduate Division requirements and information required to complete the application.

Copies of official transcripts should be uploaded to your application. Please do not mail original transcripts for the review process.

We require three letters of recommendation, which should be submitted online. If your letter writers prefer to submit paper letters, please have the letters sent to:

Graduate Assistant
University of California
Department of Mathematics
910 Evans Hall
Berkeley, CA 94720-3840

A Note on the GRE Exams

We require both the General GRE and the Mathematics Subject GRE exams. You should take both tests no later than October. The Educational Testing Service will send your scores to the institutions you specify when you take the exams. Our departmental code is 0703. Additional information about the GRE exams, and how to register, can be obtained on the GRE's website (http://www.gre.org) .

International Students

All applicants from countries in which the official language is not English are required to submit official evidence of English language proficiency. This requirement applies to applicants from Bangladesh, Nepal, India, Pakistan, Latin America, the Middle East, Israel, the People's Republic of China, Taiwan, Japan, Korea, Southeast Asia, most European countries, and non-English-speaking countries in Africa.

If you have completed at least one year of full-time academic course work with grades of B or better in residence at a US university, you do not need to take a standardized test. Instead, you must submit an official transcript from the US university.

We will only accept TOEFL tests administered by the Educational Testing Service and sent to us directly by the TOEFL office. Tests taken before June 2012 will not be accepted, even if your score was reported to Berkeley. The institution code for Berkeley is 4833. You may submit a photocopy of the Examinee's Score Report for review purposes only, but this is not a substitute for an official score report.

For purposes of admission, your most recent score must be at least 68 for the internet-based test (iBT). Students wishing to be appointed as teaching assistants in their first year should have a score of 26 on the speaking section of the iBT.

Normative Time Requirements

Normative time to advancement: five semesters.
Normative time in candidacy: seven semesters.
Total normative time: twelve semesters.

Time to Advancement

Curriculum

Four graduate-level courses
Four Math electives, as per specialized study list in Year One, including Seminar requiring a presentation of one hour or longer

Prerequisites

The Department of Mathematics offers two PhD degrees, one in Mathematics and one in Applied Mathematics. Applicants for admission to either PhD program are expected to have preparation comparable to the undergraduate major at Berkeley in Mathematics or in Applied Mathematics. These majors consist of two full years of lower division work (covering calculus, linear algebra, differential equations, and multivariable calculus), followed by eight one-semester courses including real analysis, complex analysis, abstract algebra, and linear algebra. These eight courses may include some mathematically based courses in other departments, such as physics, engineering, computer science, or economics.

Applicants for admission are considered by the department's Graduate Admissions and Appointments Committees. The number of students that can be admitted each year is determined by the Graduate Division and by departmental resources. In making admissions decisions, the committee considers, among other things, grades in mathematics courses, level of mathematical preparation, letters of recommendation, and GRE scores. Experience has shown that the score on the Mathematics Subject GRE is a partial indicator of preparation for Berkeley's PhD program. A score below the 80th percentile suggests inadequate preparation and must be balanced by other evidence if a favorable admission decision is to be reached.

Degree Requirements

In outline, to qualify for the PhD in either Mathematics or Applied Mathematics, the candidate must meet the following requirements.

1. During the first year in the PhD program:

   a. Take at least four courses, two or more of which are graduate courses in mathematics,
   b. Pass the six-hour written preliminary examination covering primarily undergraduate material. (The exam is given just before the beginning of each semester, and the student must pass it within their first three semesters.)
2. Pass a three-hour, oral qualifying examination emphasizing, but not exclusively restricted to, the area of specialization. The qualifying examination must be attempted *within two years* of entering the program.
3. Complete a seminar, giving a talk of at least one hour duration.
4. Write a dissertation embodying the results of original research and acceptable to a properly constituted dissertation committee.
5. Meet the University residence requirement of two years or four semesters.

The detailed regulations of the PhD program are as follows:

Course Requirements

During the first year in the PhD program, the student must enroll in at least four courses. At least two of these must be graduate courses in mathematics. Exceptions can be granted by the student's graduate adviser.

Preliminary Examination

The preliminary examination consists of six hours of written work given over a two-day period. Most of the examination covers material, mainly in analysis and algebra, that should be part of a well-prepared student's undergraduate training. The preliminary examination is offered twice a year—during the week before classes start in both the fall and spring semesters. A student may repeat the examination twice. A student who does not pass the preliminary examination within 13 months of the date of entry into the PhD program will not be permitted to remain in the program past the third semester. In exceptional cases, a fourth try may be granted.

Qualifying Examination

To arrange for the qualifying examination, a student must first settle on an area of concentration, and a prospective dissertation supervisor, someone who agrees to supervise the dissertation if the examination is passed. With the aid of the prospective supervisor, the student forms an examination committee of four members, at least two of which must be members of the department. The Graduate Division requires that at least one committee member be from outside the department and that the committee chair be someone other than the dissertation supervisor. The syllabus of the examination is to be worked out jointly by the committee and the student, but before final approval it is to be circulated to all faculty members of the appropriate sections. The qualifying examination must cover material falling in at least three subject areas and these must be listed on the application to take the examination. Moreover, the material covered must fall within more than one section of the department. Sample syllabi can be seen in 910 Evans Hall.

The student must attempt the qualifying examination within twenty-five months of entering the PhD program. If a student does not pass on the first attempt, then, on the recommendation of the student's examining committee, and subject to the approval of the Graduate Division, the student may repeat the examination once. The examining committee must be the same, and the re-examination must be held within thirty months of the student's entrance into the PhD program.

For a student to pass the qualifying examination, at least one identified member of the subject area group must be willing to accept the candidate as a dissertation student, if asked. The student must obtain an official dissertation supervisor within one semester after passing the qualifying examination or leave the PhD program. For more detailed rules and advice concerning the qualifying examination, consult the graduate assistant in 910 Evans Hall.

Unit Requirements

Plan I requires at least 20 semester units of upper division and graduate courses and a thesis. At least 8 of these units must be in graduate courses (200 series). These 8 units are normally taken in the Department of Mathematics at Berkeley. In special cases, upon recommendation of the Graduate Adviser and approval of the Dean of the Graduate Division, some of the 8 graduate units may be taken in other departments.

Plan II requires at least 24 semester units of upper division and graduate courses, followed by a comprehensive final examination, the MA examination. At least 12 of these units must be in graduate courses (200 series). These 12 units are normally taken in the Department of Mathematics at Berkeley. In special cases, upon recommendation of the graduate adviser and approval of the dean of the Graduate Division, some of the 12 graduate units may be taken in other departments. All courses fulfilling the above unit requirements must have significant mathematical content. In general, MA students are encouraged to take some courses outside the Department of Mathematics. In many jobs, at least some acquaintance with statistics and computer science is essential; and, for some students, courses in such fields as engineering, biological or physical sciences, or economics are highly desirable.

A breadth requirement consisting of at least one course in each of three fields must be met by all students. Fields include: algebra, analysis, geometry, foundations, history of mathematics, numerical analysis, probability and statistics, computer science, and various other fields of applied mathematics. The last category specifically covers courses in a variety of departments, and the graduate adviser may allow more than one such course to count toward the breadth requirement. A depth requirement consisting of a coherent program of three courses all in one of the above fields, at least two of these courses being at the graduate level, must be met. Students interested in a field of applied mathematics are encouraged to take some of these courses outside the department.

Curriculum

Courses Required
Breadth Requirement:
Select one courses in three fields from the following:
algebra; analysis, geometry, foundations, history of mathematics, numerical analysis, probability and statistics, computer science, applied mathematics
Depth Requirement:
Select a coherent program of three courses all in one field from the following:
algebra; analysis, geometry, foundations, history of mathematics, numerical analysis, probability and statistics, computer science, applied mathematics

- Advancement to Candidacy
- Capstone/Thesis (Plan I)
- Capstone/Comprehensive Exam (Plan II)

- Capstone/Master's Project (Plan II)

Mathematics

MATH 202A Introduction to Topology and Analysis 4 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
Metric spaces and general topological spaces. Compactness and connectedness. Characterization of compact metric spaces. Theorems of Tychonoff, Urysohn, Tietze. Complete spaces and the Baire category theorem. Function spaces; Arzela-Ascoli and Stone-Weierstrass theorems. Partitions of unity. Locally compact spaces; one-point compactification. Introduction to measure and integration. Sigma algebras of sets. Measures and outer measures. Lebesgue measure on the line and Rn. Construction of the integral. Dominated convergence theorem.
Introduction to Topology and Analysis: Read More [+]
Rules & Requirements

Prerequisites: 104

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Introduction to Topology and Analysis: Read Less [-]

MATH 202B Introduction to Topology and Analysis 4 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016
Measure and integration. Product measures and Fubini-type theorems. Signed measures; Hahn and Jordan decompositions. Radon-Nikodym theorem. Integration on the line and in Rn. Differentiation of the integral. Hausdorff measures. Fourier transform. Introduction to linear topological spaces, Banach spaces and Hilbert spaces. Banach-Steinhaus theorem; closed graph theorem. Hahn-Banach theorem. Duality; the dual of LP. Measures on locally compact spaces; the dual of C(X). Weak and weak-* topologies; Banach-Alaoglu theorem. Convexity and the Krein-Milman theorem. Additional topics chosen may include compact operators, spectral theory of compact operators, and applications to integral equations.
Introduction to Topology and Analysis: Read More [+]
Rules & Requirements

Prerequisites: 202A and 110

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Introduction to Topology and Analysis: Read Less [-]

MATH 203 Asymptotic Analysis in Applied Mathematics 4 Units

Terms offered: Fall 2011, Spring 2011, Spring 2010
Asymptotic methods for differential equations, with emphasis upon many physical examples. Topics will include matched asymptotic expansions, Laplace's method, stationary phase, boundary layers, multiple scales, WKB approximations, asymptotic Lagrangians, bifurcation theory.
Asymptotic Analysis in Applied Mathematics: Read More [+]
Rules & Requirements

Prerequisites: 104

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Asymptotic Analysis in Applied Mathematics: Read Less [-]

MATH 204 Ordinary Differential Equations 4 Units

Terms offered: Fall 2016, Spring 2016, Fall 2014
Rigorous theory of ordinary differential equations. Fundamental existence theorems for initial and boundary value problems, variational equilibria, periodic coefficients and Floquet Theory, Green's functions, eigenvalue problems, Sturm-Liouville theory, phase plane analysis, Poincare-Bendixon Theorem, bifurcation, chaos.
Ordinary Differential Equations: Read More [+]
Rules & Requirements

Prerequisites: 104

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Ordinary Differential Equations: Read Less [-]

MATH 205 Theory of Functions of a Complex Variable 4 Units

Terms offered: Spring 2018, Spring 2017, Fall 2015
Normal families. Riemann Mapping Theorem. Picard's theorem and related theorems. Multiple-valued analytic functions and Riemann surfaces. Further topics selected by the instructor may include: harmonic functions, elliptic and algebraic functions, boundary behavior of analytic functions and HP spaces, the Riemann zeta functions, prime number theorem.
Theory of Functions of a Complex Variable: Read More [+]
Rules & Requirements

Prerequisites: 185

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Theory of Functions of a Complex Variable: Read Less [-]

MATH 206 Banach Algebras and Spectral Theory 4 Units

Terms offered: Fall 2016, Fall 2015, Fall 2014
Banach algebras. Spectrum of a Banach algebra element. Gelfand theory of commutative Banach algebras. Analytic functional calculus. Hilbert space operators. C*-algebras of operators. Commutative C*-algebras. Spectral theorem for bounded self-adjoint and normal operators (both forms: the spectral integral and the "multiplication operator" formulation). Riesz theory of compact operators. Hilbert-Schmidt operators. Fredholm operators. The Fredholm index. Selected additional topics.
Banach Algebras and Spectral Theory: Read More [+]
Rules & Requirements

Prerequisites: 202A-202B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Banach Algebras and Spectral Theory: Read Less [-]

MATH 208 C*-algebras 4 Units

Terms offered: Spring 2018, Spring 2015, Spring 2013
Basic theory of C*-algebras. Positivity, spectrum, GNS construction. Group C*-algebras and connection with group representations. Additional topics, for example, C*-dynamical systems, K-theory.
C*-algebras: Read More [+]
Rules & Requirements

Prerequisites: 206

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

C*-algebras: Read Less [-]

MATH 209 Von Neumann Algebras 4 Units

Terms offered: Spring 2017, Spring 2014, Spring 2012
Basic theory of von Neumann algebras. Density theorems, topologies and normal maps, traces, comparison of projections, type classification, examples of factors. Additional topics, for example, Tomita Takasaki theory, subfactors, group actions, and noncommutative probability.
Von Neumann Algebras: Read More [+]
Rules & Requirements

Prerequisites: 206

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Von Neumann Algebras: Read Less [-]

MATH 212 Several Complex Variables 4 Units

Terms offered: Spring 2016, Fall 2014, Spring 2012
Power series developments, domains of holomorphy, Hartogs' phenomenon, pseudo convexity and plurisubharmonicity. The remainder of the course may treat either sheaf cohomology and Stein manifolds, or the theory of analytic subvarieties and spaces.
Several Complex Variables: Read More [+]
Rules & Requirements

Prerequisites: 185 and 202A-202B or their equivalents

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Several Complex Variables: Read Less [-]

MATH 214 Differentiable Manifolds 4 Units

Terms offered: Fall 2017, Spring 2017, Fall 2015
Smooth manifolds and maps, tangent and normal bundles. Sard's theorem and transversality, Whitney embedding theorem. Morse functions, differential forms, Stokes' theorem, Frobenius theorem. Basic degree theory. Flows, Lie derivative, Lie groups and algebras. Additional topics selected by instructor.
Differentiable Manifolds: Read More [+]
Rules & Requirements

Prerequisites: 202A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Differentiable Manifolds: Read Less [-]

MATH 215A Algebraic Topology 4 Units

Terms offered: Fall 2017, Spring 2017, Fall 2015
Fundamental group and covering spaces, simplicial and singular homology theory with applications, cohomology theory, duality theorem. Homotopy theory, fibrations, relations between homotopy and homology, obstruction theory, and topics from spectral sequences, cohomology operations, and characteristic classes. Sequence begins fall.
Algebraic Topology: Read More [+]
Rules & Requirements

Prerequisites: 113 and point-set topology (e.g. 202A)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructors: 113C, 202A, and 214

Algebraic Topology: Read Less [-]

MATH 215B Algebraic Topology 4 Units

Terms offered: Spring 2016, Spring 2015, Spring 2014
Fundamental group and covering spaces, simplicial and singular homology theory with applications, cohomology theory, duality theorem. Homotopy theory, fibrations, relations between homotopy and homology, obstruction theory, and topics from spectral sequences, cohomology operations, and characteristic classes. Sequence begins fall.
Algebraic Topology: Read More [+]
Rules & Requirements

Prerequisites: 215A, 214 recommended (can be taken concurrently)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructors: 113C, 202A, and 214

Algebraic Topology: Read Less [-]

MATH C218A Probability Theory 4 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
The course is designed as a sequence with Statistics C205B/ Mathematics C218B with the following combined syllabus. Measure theory concepts needed for probability. Expection, distributions. Laws of large numbers and central limit theorems for independent random variables. Characteristic function methods. Conditional expectations, martingales and martingale convergence theorems. Markov chains. Stationary processes. Brownian motion.
Probability Theory: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Also listed as: STAT C205A

Probability Theory: Read Less [-]

MATH C218B Probability Theory 4 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016
The course is designed as a sequence with with Statistics C205A/ Mathematics C218A with the following combined syllabus. Measure theory concepts needed for probability. Expection, distributions. Laws of large numbers and central limit theorems for independent random variables. Characteristic function methods. Conditional expectations, martingales and martingale convergence theorems. Markov chains. Stationary processes. Brownian motion.
Probability Theory: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Also listed as: STAT C205B

Probability Theory: Read Less [-]

MATH 219 Dynamical Systems 4 Units

Terms offered: Spring 2018, Fall 2016, Spring 2015
Diffeomorphisms and flows on manifolds. Ergodic theory. Stable manifolds, generic properties, structural stability. Additional topics selected by the instructor.
Dynamical Systems: Read More [+]
Rules & Requirements

Prerequisites: 214

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Dynamical Systems: Read Less [-]

MATH 220 Introduction to Probabilistic Methods in Mathematics and the Sciences 4 Units

Terms offered: Spring 2012, Spring 2011, Spring 2010
Brownian motion, Langevin and Fokker-Planck equations, path integrals and Feynman diagrams, time series, an introduction to statistical mechanics, Monte Carlo methods, selected applications.
Introduction to Probabilistic Methods in Mathematics and the Sciences: Read More [+]
Rules & Requirements

Prerequisites: Some familiarity with differential equations and their applications

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Introduction to Probabilistic Methods in Mathematics and the Sciences: Read Less [-]

MATH 221 Advanced Matrix Computations 4 Units

Terms offered: Spring 2018, Fall 2016, Spring 2016
Direct solution of linear systems, including large sparse systems: error bounds, iteration methods, least square approximation, eigenvalues and eigenvectors of matrices, nonlinear equations, and minimization of functions.
Advanced Matrix Computations: Read More [+]
Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Summer: 8 weeks - 6 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Advanced Matrix Computations: Read Less [-]

MATH 222A Partial Differential Equations 4 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
The theory of boundary value and initial value problems for partial differential equations, with emphasis on nonlinear equations. Laplace's equation, heat equation, wave equation, nonlinear first-order equations, conservation laws, Hamilton-Jacobi equations, Fourier transform, Sobolev spaces.
Partial Differential Equations: Read More [+]
Rules & Requirements

Prerequisites: 105 or 202A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Partial Differential Equations: Read Less [-]

MATH 222B Partial Differential Equations 4 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016
The theory of boundary value and initial value problems for partial differential equations, with emphasis on nonlinear equations. Second-order elliptic equations, parabolic and hyperbolic equations, calculus of variations methods, additional topics selected by instructor.
Partial Differential Equations: Read More [+]
Rules & Requirements

Prerequisites: 105 or 202A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Partial Differential Equations: Read Less [-]

MATH C223A Advanced Topics in Probability and Stochastic Process 3 Units

Terms offered: Fall 2016, Fall 2015, Fall 2014, Fall 2013
The topics of this course change each semester, and multiple sections may be offered. Advanced topics in probability offered according to students demand and faculty availability.
Advanced Topics in Probability and Stochastic Process: Read More [+]
Rules & Requirements

Prerequisites: Statistics C205A-C205B or consent of instructor

Repeat rules: Course may be repeated for credit with a different instructor. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Also listed as: STAT C206A

Advanced Topics in Probability and Stochastic Process: Read Less [-]

MATH C223B Advanced Topics in Probability and Stochastic Processes 3 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016
The topics of this course change each semester, and multiple sections may be offered. Advanced topics in probability offered according to students demand and faculty availability.
Advanced Topics in Probability and Stochastic Processes: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit with a different instructor. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Also listed as: STAT C206B

Advanced Topics in Probability and Stochastic Processes: Read Less [-]

MATH 224A Mathematical Methods for the Physical Sciences 4 Units

Terms offered: Fall 2016, Fall 2014, Fall 2013
Introduction to the theory of distributions. Fourier and Laplace transforms. Partial differential equations. Green's function. Operator theory, with applications to eigenfunction expansions, perturbation theory and linear and non-linear waves. Sequence begins fall.
Mathematical Methods for the Physical Sciences: Read More [+]
Rules & Requirements

Prerequisites: Graduate status or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructors: 112 or 113C; 104A and 185, or 121A-121B-121C, or 120A-120B-120C.

Mathematical Methods for the Physical Sciences: Read Less [-]

MATH 224B Mathematical Methods for the Physical Sciences 4 Units

Terms offered: Spring 2015, Spring 2014, Spring 2013
Introduction to the theory of distributions. Fourier and Laplace transforms. Partial differential equations. Green's function. Operator theory, with applications to eigenfunction expansions, perturbation theory and linear and non-linear waves. Sequence begins fall.
Mathematical Methods for the Physical Sciences: Read More [+]
Rules & Requirements

Prerequisites: Graduate status or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Mathematical Methods for the Physical Sciences: Read Less [-]

MATH 225A Metamathematics 4 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
Metamathematics of predicate logic. Completeness and compactness theorems. Interpolation theorem, definability, theory of models. Metamathematics of number theory, recursive functions, applications to truth and provability. Undecidable theories. Sequence begins fall.
Metamathematics: Read More [+]
Rules & Requirements

Prerequisites: 125B and 135

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructor: 125B and 135.

Metamathematics: Read Less [-]

MATH 225B Metamathematics 4 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016
Metamathematics of predicate logic. Completeness and compactness theorems. Interpolation theorem, definability, theory of models. Metamathematics of number theory, recursive functions, applications to truth and provability. Undecidable theories. Sequence begins fall.
Metamathematics: Read More [+]
Rules & Requirements

Prerequisites: 125B and 135

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructor: 125B and 135.

Metamathematics: Read Less [-]

MATH 227A Theory of Recursive Functions 4 Units

Terms offered: Fall 2015, Fall 2013, Spring 2012
Recursive and recursively enumerable sets of natural numbers; characterizations, significance, and classification. Relativization, degrees of unsolvability. The recursion theorem. Constructive ordinals, the hyperarithmetical and analytical hierarchies. Recursive objects of higher type. Sequence begins fall.
Theory of Recursive Functions: Read More [+]
Rules & Requirements

Prerequisites: Mathematics
225B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructor: 225C.

Theory of Recursive Functions: Read Less [-]

MATH 228A Numerical Solution of Differential Equations 4 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
Ordinary differential equations: Runge-Kutta and predictor-corrector methods; stability theory, Richardson extrapolation, stiff equations, boundary value problems. Partial differential equations: stability, accuracy and convergence, Von Neumann and CFL conditions, finite difference solutions of hyperbolic and parabolic equations. Finite differences and finite element solution of elliptic equations.
Numerical Solution of Differential Equations: Read More [+]
Rules & Requirements

Prerequisites: 128A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructor: 128A-128B.

Numerical Solution of Differential Equations: Read Less [-]

MATH 228B Numerical Solution of Differential Equations 4 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016
Ordinary differential equations: Runge-Kutta and predictor-corrector methods; stability theory, Richardson extrapolation, stiff equations, boundary value problems. Partial differential equations: stability, accuracy and convergence, Von Neumann and CFL conditions, finite difference solutions of hyperbolic and parabolic equations. Finite differences and finite element solution of elliptic equations.
Numerical Solution of Differential Equations: Read More [+]
Rules & Requirements

Prerequisites: 128A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructor: 128A-128B.

Numerical Solution of Differential Equations: Read Less [-]

MATH 229 Theory of Models 4 Units

Terms offered: Spring 2015, Spring 2013, Spring 2012
Syntactical characterization of classes closed under algebraic operations. Ultraproducts and ultralimits, saturated models. Methods for establishing decidability and completeness. Model theory of various languages richer than first-order.
Theory of Models: Read More [+]
Rules & Requirements

Prerequisites: 225B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Theory of Models: Read Less [-]

MATH 235A Theory of Sets 4 Units

Terms offered: Spring 2014, Fall 2011, Spring 2008
Axiomatic foundations. Operations on sets and relations. Images and set functions. Ordering, well-ordering, and well-founded relations; general principles of induction and recursion. Ranks of sets, ordinals and their arithmetic. Set-theoretical equivalence, similarity of relations; definitions by abstraction. Arithmetic of cardinals. Axiom of choice, equivalent forms, and consequences. Sequence begins fall.
Theory of Sets: Read More [+]
Rules & Requirements

Prerequisites: 125A and 135

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructor: 125A and 135.

Theory of Sets: Read Less [-]

MATH 236 Metamathematics of Set Theory 4 Units

Terms offered: Fall 2014, Fall 2010, Spring 2009
Various set theories: comparison of strength, transitive, and natural models, finite axiomatizability. Independence and consistency of axiom of choice, continuum hypothesis, etc. The measure problem and axioms of strong infinity.
Metamathematics of Set Theory: Read More [+]
Rules & Requirements

Prerequisites: 225B and 235A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Metamathematics of Set Theory: Read Less [-]

MATH 239 Discrete Mathematics for the Life Sciences 4 Units

Terms offered: Spring 2011, Fall 2008, Spring 2008
Introduction to algebraic statistics and probability, optimization, phylogenetic combinatorics, graphs and networks, polyhedral and metric geometry.
Discrete Mathematics for the Life Sciences: Read More [+]
Rules & Requirements

Prerequisites: Statistics 134 or equivalent introductory probability theory course, or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Discrete Mathematics for the Life Sciences: Read Less [-]

MATH C239 Discrete Mathematics for the Life Sciences 4 Units

Terms offered: Spring 2013
Introduction to algebraic statistics and probability, optimization, phylogenetic combinatorics, graphs and networks, polyhedral and metric geometry.
Discrete Mathematics for the Life Sciences: Read More [+]
Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Also listed as: MCELLBI C244

Discrete Mathematics for the Life Sciences: Read Less [-]

MATH 240 Riemannian Geometry 4 Units

Terms offered: Fall 2016, Fall 2015, Fall 2014
Riemannian metric and Levi-Civita connection, geodesics and completeness, curvature, first and second variations of arc length. Additional topics such as the theorems of Myers, Synge, and Cartan-Hadamard, the second fundamental form, convexity and rigidity of hypersurfaces in Euclidean space, homogeneous manifolds, the Gauss-Bonnet theorem, and characteristic classes.
Riemannian Geometry: Read More [+]
Rules & Requirements

Prerequisites: 214

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Riemannian Geometry: Read Less [-]

MATH 241 Complex Manifolds 4 Units

Terms offered: Fall 2017, Fall 2014, Spring 2013
Riemann surfaces, divisors and line bundles on Riemann surfaces, sheaves and the Dolbeault theorem on Riemann surfaces, the classical Riemann-Roch theorem, theorem of Abel-Jacobi. Complex manifolds, Kahler metrics. Summary of Hodge theory, groups of line bundles, additional topics such as Kodaira's vanishing theorem, Lefschetz hyperplane theorem.
Complex Manifolds: Read More [+]
Rules & Requirements

Prerequisites: 214 and 215A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Complex Manifolds: Read Less [-]

MATH 242 Symplectic Geometry 4 Units

Terms offered: Fall 2017, Fall 2015, Spring 2014
Basic topics: symplectic linear algebra, symplectic manifolds, Darboux theorem, cotangent bundles, variational problems and Legendre transform, hamiltonian systems, Lagrangian submanifolds, Poisson brackets, symmetry groups and momentum mappings, coadjoint orbits, Kahler manifolds.
Symplectic Geometry: Read More [+]
Rules & Requirements

Prerequisites: 214

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Symplectic Geometry: Read Less [-]

MATH C243 Seq: Methods and Applications 3 Units

Terms offered: Spring 2015, Spring 2014
A graduate seminar class in which a group of students will closely examine recent computational methods in high-throughput sequencing followed by directly examining interesting biological applications thereof.
Seq: Methods and Applications: Read More [+]
Rules & Requirements

Prerequisites: Graduate standing in Math, MCB, and Computational Biology; or consent of the instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructor: Pachter

Also listed as: MCELLBI C243

Seq: Methods and Applications: Read Less [-]

MATH 245A General Theory of Algebraic Structures 4 Units

Terms offered: Fall 2017, Fall 2015, Spring 2014
Structures defined by operations and/or relations, and their homomorphisms. Classes of structures determined by identities. Constructions such as free objects, objects presented by generators and relations, ultraproducts, direct limits. Applications of general results to groups, rings, lattices, etc. Course may emphasize study of congruence- and subalgebra-lattices, or category-theory and adjoint functors, or other aspects.
General Theory of Algebraic Structures: Read More [+]
Rules & Requirements

Prerequisites: Math 113

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

General Theory of Algebraic Structures: Read Less [-]

MATH 249 Algebraic Combinatorics 4 Units

Terms offered: Fall 2017, Fall 2016, Spring 2015
(I) Enumeration, generating functions and exponential structures, (II) Posets and lattices, (III) Geometric combinatorics, (IV) Symmetric functions, Young tableaux, and connections with representation theory. Further study of applications of the core material and/or additional topics, chosen by instructor.
Algebraic Combinatorics: Read More [+]
Rules & Requirements

Prerequisites: 250A or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Algebraic Combinatorics: Read Less [-]

MATH 250A Groups, Rings, and Fields 4 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
Group theory, including the Jordan-Holder theorem and the Sylow theorems. Basic theory of rings and their ideals. Unique factorization domains and principal ideal domains. Modules. Chain conditions. Fields, including fundamental theorem of Galois theory, theory of finite fields, and transcendence degree.
Groups, Rings, and Fields: Read More [+]
Rules & Requirements

Prerequisites: 114 or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Groups, Rings, and Fields: Read Less [-]

MATH 250B Multilinear Algebra and Further Topics 4 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016
Tensor algebras and exterior algebras, with application to linear transformations. Commutative ideal theory, localization. Elementary specialization and valuation theory. Related topics in algebra.
Multilinear Algebra and Further Topics: Read More [+]
Rules & Requirements

Prerequisites: 250A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Multilinear Algebra and Further Topics: Read Less [-]

MATH 251 Ring Theory 4 Units

Terms offered: Fall 2016, Spring 2013, Fall 2009
Topics such as: Noetherian rings, rings with descending chain condition, theory of the radical, homological methods.
Ring Theory: Read More [+]
Rules & Requirements

Prerequisites: 250A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Ring Theory: Read Less [-]

MATH 252 Representation Theory 4 Units

Terms offered: Fall 2015, Fall 2014, Fall 2013
Structure of finite dimensional algebras, applications to representations of finite groups, the classical linear groups.
Representation Theory: Read More [+]
Rules & Requirements

Prerequisites: 250A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Representation Theory: Read Less [-]

MATH 253 Homological Algebra 4 Units

Terms offered: Fall 2016, Fall 2014, Summer 2014 10 Week Session
Modules over a ring, homomorphisms and tensor products of modules, functors and derived functors, homological dimension of rings and modules.
Homological Algebra: Read More [+]
Rules & Requirements

Prerequisites: 250A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Homological Algebra: Read Less [-]

MATH 254A Number Theory 4 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
Valuations, units, and ideals in number fields, ramification theory, quadratic and cyclotomic fields, topics from class field theory, zeta-functions and L-series, distribution of primes, modular forms, quadratic forms, diophantine equations, P-adic analysis, and transcendental numbers. Sequence begins fall.
Number Theory: Read More [+]
Rules & Requirements

Prerequisites: 250A for 254A; 254A for 254B

Repeat rules: 254B may be repeated with consent of instructor. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructor: 250A.

Number Theory: Read Less [-]

MATH 254B Number Theory 4 Units

Terms offered: Spring 2018, Spring 2017, Spring 2015
Valuations, units, and ideals in number fields, ramification theory, quadratic and cyclotomic fields, topics from class field theory, zeta-functions and L-series, distribution of primes, modular forms, quadratic forms, diophantine equations, P-adic analysis, and transcendental numbers. Sequence begins fall.
Number Theory: Read More [+]
Rules & Requirements

Prerequisites: 254A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructor: 250A.

Number Theory: Read Less [-]

MATH 255 Algebraic Curves 4 Units

Terms offered: Fall 2014, Fall 2011, Spring 2009
Elliptic curves. Algebraic curves, Riemann surfaces, and function fields. Singularities. Riemann-Roch theorem, Hurwitz's theorem, projective embeddings and the canonical curve. Zeta functions of curves over finite fields. Additional topics such as Jacobians or the Riemann hypothesis.
Algebraic Curves: Read More [+]
Rules & Requirements

Prerequisites: 250A-250B or consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Algebraic Curves: Read Less [-]

MATH 256A Algebraic Geometry 4 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
Affine and projective algebraic varieties. Theory of schemes and morphisms of schemes. Smoothness and differentials in algebraic geometry. Coherent sheaves and their cohomology. Riemann-Roch theorem and selected applications. Sequence begins fall.
Algebraic Geometry: Read More [+]
Rules & Requirements

Prerequisites: 250A-250B for 256A; 256A for 256B

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructor: 250A.

Algebraic Geometry: Read Less [-]

MATH 256B Algebraic Geometry 4 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016
Affine and projective algebraic varieties. Theory of schemes and morphisms of schemes. Smoothness and differentials in algebraic geometry. Coherent sheaves and their cohomology. Riemann-Roch theorem and selected applications. Sequence begins fall.
Algebraic Geometry: Read More [+]
Rules & Requirements

Prerequisites: 256A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructor: 250A.

Algebraic Geometry: Read Less [-]

MATH 257 Group Theory 4 Units

Terms offered: Spring 2018, Spring 2014, Fall 2011
Topics such as: generators and relations, infinite discrete groups, groups of Lie type, permutation groups, character theory, solvable groups, simple groups, transfer and cohomological methods.
Group Theory: Read More [+]
Rules & Requirements

Prerequisites: 250A

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Group Theory: Read Less [-]

MATH 258 Harmonic Analysis 4 Units

Terms offered: Fall 2016, Spring 2015, Spring 2012
Basic properties of Fourier series, convergence and summability, conjugate functions, Hardy spaces, boundary behavior of analytic and harmonic functions. Additional topics at the discretion of the instructor.
Harmonic Analysis: Read More [+]
Rules & Requirements

Prerequisites: 206 or a basic knowledge of real, complex, and linear analysis

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Harmonic Analysis: Read Less [-]

MATH 261A Lie Groups 4 Units

Terms offered: Spring 2017, Fall 2015, Fall 2013
Lie groups and Lie algebras, fundamental theorems of Lie, general structure theory; compact, nilpotent, solvable, semi-simple Lie groups; classification theory and representation theory of semi-simple Lie algebras and Lie groups, further topics such as symmetric spaces, Lie transformation groups, etc., if time permits. In view of its simplicity and its wide range of applications, it is preferable to cover compact Lie groups and their representations in 261A. Sequence begins Fall.
Lie Groups: Read More [+]
Rules & Requirements

Prerequisites: 214

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructor: 214.

Lie Groups: Read Less [-]

MATH 261B Lie Groups 4 Units

Terms offered: Fall 2017, Spring 2016, Spring 2014
Lie groups and Lie algebras, fundamental theorems of Lie, general structure theory; compact, nilpotent, solvable, semi-simple Lie groups; classification theory and representation theory of semi-simple Lie algebras and Lie groups, further topics such as symmetric spaces, Lie transformation groups, etc., if time permits. In view of its simplicity and its wide range of applications, it is preferable to cover compact Lie groups and their representations in 261A. Sequence begins Fall.
Lie Groups: Read More [+]
Rules & Requirements

Prerequisites: 214

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Instructor: 214.

Lie Groups: Read Less [-]

MATH 265 Differential Topology 4 Units

Terms offered: Spring 2011, Fall 2008, Fall 2004
Approximations, degrees of maps, vector bundles, tubular neighborhoods. Introduction to Morse theory, handlebodies, cobordism, surgery. Additional topics selected by instructor from: characteristic classes, classification of manifolds, immersions, embeddings, singularities of maps.
Differential Topology: Read More [+]
Rules & Requirements

Prerequisites: 214 plus 215A or some familiarity with algebraic topology

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Differential Topology: Read Less [-]

MATH 270 Hot Topics Course in Mathematics 2 Units

Terms offered: Spring 2018, Fall 2017, Spring 2017
This course will give introductions to current research developments. Every semester we will pick a different topic and go through the relevant literature. Each student will be expected to give one presentation.
Hot Topics Course in Mathematics: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit as topic varies. Course may be repeated for credit when topic changes.

Hours & Format

Fall and/or spring: 15 weeks - 1.5 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Hot Topics Course in Mathematics: Read Less [-]

MATH 273 Topics in Numerical Analysis 4 Units

Terms offered: Spring 2016, Spring 2014
Advanced topics chosen by the instructor. The content of this course changes, as in the case of seminars.
Topics in Numerical Analysis: Read More [+]
Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Topics in Numerical Analysis: Read Less [-]

MATH 274 Topics in Algebra 4 Units

Terms offered: Spring 2018, Spring 2017, Fall 2016
Advanced topics chosen by the instructor. The content of this course changes, as in the case of seminars.
Topics in Algebra: Read More [+]
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Topics in Algebra: Read Less [-]

MATH 275 Topics in Applied Mathematics 4 Units

Terms offered: Spring 2017, Spring 2014, Fall 2013
Advanced topics chosen by the instructor. The content of this course changes, as in the case of seminars.
Topics in Applied Mathematics: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Topics in Applied Mathematics: Read Less [-]

MATH 276 Topics in Topology 4 Units

Terms offered: Fall 2017, Spring 2016, Spring 2015
Advanced topics chosen by the instructor. The content of this course changes, as in the case of seminars.
Topics in Topology: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Topics in Topology: Read Less [-]

MATH 277 Topics in Differential Geometry 4 Units

Terms offered: Spring 2018, Spring 2017, Spring 2016
Advanced topics chosen by the instructor. The content of this course changes, as in the case of seminars.
Topics in Differential Geometry: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Topics in Differential Geometry: Read Less [-]

MATH 278 Topics in Analysis 4 Units

Terms offered: Spring 2018, Fall 2015, Spring 2015
Advanced topics chosen by the instructor. The content of this course changes, as in the case of seminars.
Topics in Analysis: Read More [+]

Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Topics in Analysis: Read Less [-]

MATH 279 Topics in Partial Differential Equations 4 Units

Terms offered: Fall 2017, Spring 2017, Spring 2016
Advanced topics chosen by the instructor. The content of this course changes, as in the case of seminars.
Topics in Partial Differential Equations: Read More [+]
Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Topics in Partial Differential Equations: Read Less [-]

MATH 290 Seminars 1 - 6 Units

Terms offered: Spring 2017, Spring 2015, Fall 2014
Topics in foundations of mathematics, theory of numbers, numerical calculations, analysis, geometry, topology, algebra, and their applications, by means of lectures and informal conferences; work based largely on original memoirs.
Seminars: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit.

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of seminar per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: Letter grade.

Seminars: Read Less [-]

MATH 295 Individual Research 1 - 12 Units

Terms offered: Summer 2016 10 Week Session, Spring 2016, Fall 2015
Intended for candidates for the Ph.D. degree.
Individual Research: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit.

Hours & Format

Fall and/or spring: 15 weeks - 1-12 hours of independent study per week

Summer:
3 weeks - 5 hours of independent study per week
6 weeks - 2.5-30 hours of independent study per week
8 weeks - 1.5-60 hours of independent study per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: The grading option will be decided by the instructor when the class is offered.

Individual Research: Read Less [-]

MATH 299 Reading Course for Graduate Students 1 - 6 Units

Terms offered: Fall 2017, Fall 2016, Fall 2015
Investigation of special problems under the direction of members of the department.
Reading Course for Graduate Students: Read More [+]
Rules & Requirements

Repeat rules: Course may be repeated for credit.

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of independent study per week

Summer:
6 weeks - 1-5 hours of independent study per week
8 weeks - 1-4 hours of independent study per week

Additional Details

Subject/Course Level: Mathematics/Graduate

Grading: The grading option will be decided by the instructor when the class is offered.

Reading Course for Graduate Students: Read Less [-]

MATH 301 Undergraduate Mathematics Instruction 1 - 2 Units

Terms offered: Fall 2017, Spring 2017, Fall 2016
May be taken for one unit by special permission of instructor. Tutoring at the Student Learning Center or for the Professional Development Program.
Undergraduate Mathematics Instruction: Read More [+]

Rules & Requirements

Prerequisites: Permission of SLC instructor, as well as sophomore standing and at least a B average in two semesters of calculus. Apply at Student Learning Center

Repeat rules: Course may be repeated once for credit.Course may be repeated for a maximum of 4 units.

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of seminar and 4 hours of tutorial per week

Additional Details

Subject/Course Level: Mathematics/Professional course for teachers or prospective teachers

Grading: Offered for pass/not pass grade only.

Undergraduate Mathematics Instruction: Read Less [-]

MATH 302 Teaching Workshop 1 Unit

Terms offered: Summer 2002 10 Week Session, Summer 2001 10 Week Session
Mandatory for all graduate student instructors teaching summer course for the first time in the Department. The course consists of practice teaching, alternatives to standard classroom methods, guided group and self-analysis, classroom visitations by senior faculty member.
Teaching Workshop: Read More [+]

Hours & Format

Summer: 8 weeks - 1 hour of lecture per week

Additional Details

Subject/Course Level: Mathematics/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

Teaching Workshop: Read Less [-]

MATH 303 Professional Preparation: Supervised Teaching of Mathematics 2 - 4 Units

Terms offered: Spring 2017, Spring 2016, Fall 2015
Meeting with supervising faculty and with discussion sections. Experience in teaching under the supervision of Mathematics faculty.
Professional Preparation: Supervised Teaching of Mathematics: Read More [+]

Rules & Requirements

Prerequisites: 300, graduate standing and appointment as a Graduate Student Instructor

Repeat rules: Course may be repeated four times for credit.

Hours & Format

Fall and/or spring: 15 weeks - 2-4 hours of independent study per week

Additional Details

Subject/Course Level: Mathematics/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

Professional Preparation: Supervised Teaching of Mathematics: Read Less [-]

MATH 375 Teaching Workshop 4 Units

Terms offered: Spring 2018, Fall 2017, Spring 2017
Mandatory for all graduate student instructors teaching for the first time in the Mathematics Department. The course consists of practice teaching, alternatives to standard classroom methods, guided group and self-analysis of videotapes, reciprocal classroom visitations, and an individual project.
Teaching Workshop: Read More [+]

Rules & Requirements

Prerequisites: 300, graduate standing and appointment as a Graduate Student Instructor

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture per week

Additional Details

Subject/Course Level: Mathematics/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

Formerly known as: Mathematics 300

Teaching Workshop: Read Less [-]

MATH 600 Individual Study for Master's Students 1 - 6 Units

Terms offered: Summer 2006 10 Week Session, Fall 2005, Spring 2005
Individual study for the comprehensive or language requirements in consultation with the field adviser.
Individual Study for Master's Students: Read More [+]

Rules & Requirements

Prerequisites: For candidates for master's degree

Credit Restrictions: Course does not satisfy unit or residence requirements for master's degree.

Repeat rules: Course may be repeated for credit.

Hours & Format

Fall and/or spring: 15 weeks - 1-6 hours of independent study per week

Summer: 8 weeks - 1.5-10 hours of independent study per week

Additional Details

Subject/Course Level: Mathematics/Graduate examination preparation

Grading: Offered for satisfactory/unsatisfactory grade only.

Individual Study for Master's Students: Read Less [-]

MATH 602 Individual Study for Doctoral Students 1 - 8 Units

Terms offered: Fall 2016, Fall 2015, Spring 2015
Individual study in consultation with the major field adviser intended to provide an opportunity for qualified students to prepare themselves for the various examinations required for candidates for the Ph.D. Course does not satisfy unit or residence requirements for doctoral degree.
Individual Study for Doctoral Students: Read More [+]

Rules & Requirements

Prerequisites: For qualified graduate students

Repeat rules: Course may be repeated for credit.

Hours & Format

Fall and/or spring: 15 weeks - 1-8 hours of independent study per week

Additional Details

Subject/Course Level: Mathematics/Graduate examination preparation

Grading: Offered for satisfactory/unsatisfactory grade only.

Individual Study for Doctoral Students: Read Less [-]