Department of Mathematics

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Overview

The Department of Mathematics is engaged in teaching and in fundamental research in a wide variety of basic mathematical disciplines, and offers undergraduate and graduate students the opportunity to fashion a thorough program of study leading to professional competence in mathematical research or in an area of application.

The curriculum in mathematics includes opportunities for supervised individual study and research and is augmented by seminars and colloquia. It is designed to be compatible with curricular structures at other collegiate institutions in California in order to enable students transferring to UCI to continue their programs of mathematics study.

Undergraduate Program

The Department offers a B.S. in Mathematics. Within this program there are six tracks; besides the standard track, there are five specializations or concentrations (in Mathematical Biology, Mathematical Finance, Applied and Computational Mathematics, Mathematics for Education, and Mathematics for Education/Secondary Teaching Certification). In addition, the Department offers minors in Mathematics and Mathematics for Biology.

Undergraduate mathematics courses are of several kinds: courses preparatory to advanced work in mathematics, the exact sciences, and engineering; courses for students of the social and biological sciences; and courses for liberal arts students and those planning to enter the teaching field.

Admission to the Major

Students may be admitted to the Mathematics major upon entering the University as freshmen, via change of major, or as transfer students from other colleges and universities. Information about change of major policies is available in the Physical Sciences Student Affairs Office and at the UCI Change of Major Criteria website (http://www.changeofmajor.uci.edu). For transfer student admission, preference will be given to junior-level applicants with the highest grades overall and who have satisfactorily completed the required coursework of one year of approved calculus. Additional course work in multivariable calculus, linear algebra, and differential equations is strongly recommended.

Requirements for the B.S. in Mathematics (including Concentrations and Specializations)

All students must meet the University Requirements (http://catalogue.uci.edu/informationforadmittedstudents/requirementsforabachelorsdegree)**.**
School Requirements: None.

Core Requirements for all Mathematics Majors

Lower-Division Requirements:	
A. Complete the following:	
MATH 2A- 2B	Single-Variable Calculus and Single-Variable Calculus
MATH 2D	Multivariable Calculus
MATH 3A	Introduction to Linear Algebra
MATH 3D	Elementary Differential Equations
MATH 13	Introduction to Abstract Mathematics
B. Computing skills:	
MATH 9	Introduction to Programming for Numerical Analysis
C. Select one three-quarter lecture course sequence from the following:	
CHEM 1A- 1B- 1C	General Chemistry and General Chemistry and General Chemistry
PHYSICS 7C- 7D- 7E	Classical Physics and Classical Physics and Classical Physics
Upper-Division Requirements:	
A. Complete:	
MATH 120A	Introduction to Abstract Algebra: Groups

MATH 121A	Linear Algebra
MATH 130A	Probability and Stochastic Processes
MATH 140A- 140B	Elementary Analysis and Elementary Analysis

Requirements for the Pure Mathematics Major

Core requirements for all Mathematics majors plus:	
Lower-Division Requirements:	
A. Complete:	
MATH 2E	Multivariable Calculus
Upper-Division Requirements:	
A. Complete:	
MATH 120B	Introduction to Abstract Algebra: Rings and Fields
MATH 121B	Linear Algebra
MATH 147	Complex Analysis
B. Five additional four-unit MATH lecture courses numbered 100–189.	

Sample Program — Pure Mathematics

Freshman		
Fall	**Winter**	**Spring**
MATH 2A	MATH 2B	MATH 2D
PHYSICS 7C- 7LC (or CHEM 1A)	PHYSICS 7D- 7LD (or CHEM 1B)	PHYSICS 7E or CHEM 1C
General Education/Elective	MATH 13	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective
Sophomore		
Fall	**Winter**	**Spring**
General Education/Elective	MATH 3A	MATH 3D
MATH 2E	MATH 9	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective
Junior		
Fall	**Winter**	**Spring**
MATH 130A	MATH 140A	MATH 140B
MATH 120A	MATH 120B	MATH 141
General Education/Elective	General Education/Elective	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective
Senior		
Fall	**Winter**	**Spring**
MATH 121A	MATH 121B	MATH 115
MATH 150	MATH 147	General Education/Elective
MATH 112A	MATH 180A	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective

The Department offers two concentrations and three specializations. Note that all require the completion of an application and an interview with the faculty advisor for that concentration or specialization. **Admission into a concentration or specialization is not guaranteed.** Students must complete the basic "Core" requirements for the B.S. in Mathematics along with the lower- and upper-division requirements specified for each concentration and specialization.

Requirements for Mathematics Major with a Concentration in Data Science

Admission to this specialization requires approval in advance by the Mathematics Department. The admissions process begins with completing a form at the Department office, and includes an interview with the Department’s advisor for the specialization. This approval should be applied for no later than the end of the junior year.

Core requirements for all Mathematics majors plus:	
Lower-Division Requirements:	
A. Complete:	
MATH 2E	Multivariable Calculus
B. Replace item C in the Core Requirements with the following:	

MATH 10	Introduction to Programming for Data Science
STATS 7	Basic Statistics
PHYSICS 7C	Classical Physics
Upper-Division Requirements	
A. Complete:	
MATH 105A- 105B	Numerical Analysis and Numerical Analysis
MATH 121B	Linear Algebra
MATH 130B	Probability and Stochastic Processes
MATH 110A- 110B	Optimization I and Optimization II
B. Select three electives from the following: [1]	
MATH 115	Mathematical Modeling
MATH 117	Dynamical Systems
MATH 118	The Theory of Differential Equations
MATH 130C	Probability and Stochastic Processes
MATH 133A- 133B	Statistical Methods with Applications to Finance and Statistical Methods with Applications to Finance
MATH 140C	Analysis in Several Variables
MATH 162A- 162B	Introduction to Differential Geometry and Introduction to Differential Geometry
MATH 173A- 173B	Introduction to Cryptology and Introduction to Cryptology
MATH 175	Combinatorics
MATH 176	Mathematics of Finance
STATS 110	Statistical Methods for Data Analysis I
COMPSCI 171	Introduction to Artificial Intelligence
COMPSCI 172B	Neural Networks and Deep Learning
COMPSCI 177	Applications of Probability in Computer Science
COMPSCI 178	Machine Learning and Data-Mining
COMPSCI 179	Algorithms for Probabilistic and Deterministic Graphical Models
COMPSCI 183	Introduction to Computational Biology
COMPSCI 184A- 184C	Representations and Algorithms for Molecular Biology and Computational Systems Biology
I&C SCI 105	Digital Information Systems

1 At least one of the electives must be from outside the Mathematics department. Other upper-division elective courses may be chosen with the approval of the faculty advisor.

Requirements for Mathematics Major with a Concentration in Mathematical Finance

Admission to this concentration requires approval in advance by the Mathematics Department. The department may limit the number of students admitted into this concentration during impacted years. The admissions process begins with completing a form at the Department office and includes an interview with the Department's advisor for the concentration. This approval should be applied for after the student has completed ECON 20A-ECON 20B, but no later than the end of the junior year.

Core requirements for all Mathematics majors plus:	
Lower-Division Requirements:	
A. Complete:	
MATH 2E	Multivariable Calculus
Upper-Division Requirements:	
A. Complete:	
MATH 130B	Probability and Stochastic Processes
MATH 133A	Statistical Methods with Applications to Finance
MATH 133B	Statistical Methods with Applications to Finance
B. Select three elective lecture courses from the following:	

MATH 105A- 105B	Numerical Analysis and Numerical Analysis (plus MATH 105LA-105LB)
MATH 107	Numerical Differential Equations (plus MATH 107L)
MATH 112A- 112B- 112C	Introduction to Partial Differential Equations and Applications and Introduction to Partial Differential Equations and Applications and Introduction to Partial Differential Equations and Applications
MATH 115	Mathematical Modeling
MATH 117	Dynamical Systems
MATH 118	The Theory of Differential Equations
MATH 121B	Linear Algebra
MATH 130C	Probability and Stochastic Processes
MATH 133C	Statistical Methods with Applications to Finance
MATH 140C	Analysis in Several Variables
MATH 176	Mathematics of Finance
C. Complete the following eight required Economics courses:	
ECON 20A- 20B	Basic Economics I and Basic Economics II
ECON 105A- 105B- 105C	Intermediate Quantitative Economics I and Intermediate Quantitative Economics II and Intermediate Quantitative Economics III
ECON 122A	Applied Econometrics I
or ECON 123A	Econometrics I
ECON 132A	Introduction to Financial Investments
ECON 134A	Corporate Finance

Sample Program — Mathematics Major Concentrating in Mathematical Finance

Freshman		
Fall	**Winter**	**Spring**
MATH 2A	MATH 2B	MATH 2D
PHYSICS 7C- 7LC (or CHEM 1A)	PHYSICS 7D- 7LD (or CHEM 1B)	PHYSICS 7E or CHEM 1C
General Education/Elective	MATH 13	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective
Sophomore		
Fall	**Winter**	**Spring**
MATH 2E	MATH 3A	MATH 3D
ECON 20A	ECON 20B	General Education/Elective
General Education/Elective	MATH 9	General Education/Elective
General Education/Elective	General Education/Elective	
Junior		
Fall	**Winter**	**Spring**
MATH 130A	MATH 130B	ECON 122A
MATH 140A	MATH 140B	MATH 140C
ECON 105A	ECON 105B	ECON 105C
General Education/Elective	General Education/Elective	General Education/Elective
Senior		
Fall	**Winter**	**Spring**
MATH 120A	MATH 133A	MATH 133B
MATH 118	MATH 176	MATH 115
ECON 134A	ECON 132A	MATH 121A
General Education/Elective	General Education/Elective	General Education/Elective

Requirements for Mathematics Major with a Specialization in Applied and Computational Mathematics

Admission to this specialization requires approval in advance by the Mathematics Department. The admissions process begins with completing a form at the Department office, and includes an interview with the Department’s advisor for the specialization. This approval should be applied for no later than the end of the junior year.

Core requirements for all Mathematics majors plus:
Lower-Division Requirements:

A. Complete:	
MATH 2E	Multivariable Calculus
Upper-Division Requirements:	
A. Six required lecture courses:	
MATH 105A- 105B	Numerical Analysis and Numerical Analysis (plus MATH 105LA-LB)
MATH 112A- 112B	Introduction to Partial Differential Equations and Applications and Introduction to Partial Differential Equations and Applications
MATH 115	Mathematical Modeling
MATH 121B	Linear Algebra
B. Select three additional Mathematics courses from the following:	
MATH 107	Numerical Differential Equations (plus MATH 107L)
MATH 112C	Introduction to Partial Differential Equations and Applications
MATH 117	Dynamical Systems
MATH 118	The Theory of Differential Equations
MATH 130B- 130C	Probability and Stochastic Processes and Probability and Stochastic Processes
MATH 133A- 133B	Statistical Methods with Applications to Finance and Statistical Methods with Applications to Finance
MATH 140C	Analysis in Several Variables
MATH 176	Mathematics of Finance
C. Two approved upper-division courses in an area of application outside of Mathematics. Approval must be obtained in advance from the advisor for this specialization. The student is responsible for satisfying any prerequisites for these courses.	

Sample Program — Mathematics Major Specializing in Applied and Computational Mathematics

Freshman		
Fall	**Winter**	**Spring**
MATH 2A	MATH 2B	MATH 2D
PHYSICS 7C- 7LC (or CHEM 1A)	PHYSICS 7D- 7LD (or CHEM 1B)	PHYSICS 7E or CHEM 1C
General Education/Elective	General Education/Elective	MATH 13
General Education/Elective	General Education/Elective	General Education/Elective
Sophomore		
Fall	**Winter**	**Spring**
MATH 2E	MATH 3A	MATH 3D
MATH 9	General Education/Elective	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective
Junior		
Fall	**Winter**	**Spring**
MATH 112A	MATH 112B	MATH 115
MATH 121A	MATH 121B	MATH 140B
MATH 130A	MATH 140A	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective
Senior		
Fall	**Winter**	**Spring**
MATH 105A- 105LA	MATH 105B- 105LB	MATH 107- 107L
MATH 117	MATH 118	Technical Elective
MATH 120A	Technical Elective	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective

Requirements for Mathematics Major with a Specialization in Mathematical Biology

Admission to this specialization requires approval in advance by the Mathematics Department. The admissions process begins with completing a form at the Department Office, and includes an interview with the Department’s advisor for the specialization. This approval should be applied for no later than the end of the junior year.

Core requirements for all Mathematics majors plus:	
Lower-Division Requirements:	
A. Complete:	

MATH 2E	Multivariable Calculus
B. Replace item C in the Core Requirements with the following:	
BIO SCI 93	From DNA to Organisms
BIO SCI 94	From Organisms to Ecosystems
and two courses selected from the following:	
BIO SCI 97	Genetics
CHEM 1A	General Chemistry
CHEM 1B	General Chemistry
PHYSICS 2	Introduction to Mathematical Methods for Physics
PHYSICS 7C	Classical Physics
PHYSICS 7D	Classical Physics
Upper-Division Requirements:	
A. Complete the following seven required upper-division lecture courses:	
MATH 105A- 105B	Numerical Analysis and Numerical Analysis (plus MATH 105LA-LB)
MATH 112A- 112B	Introduction to Partial Differential Equations and Applications and Introduction to Partial Differential Equations and Applications
MATH 113A- 113B	Mathematical Modeling in Biology and Mathematical Modeling in Biology
MATH 115	Mathematical Modeling
B. Two additional elective courses, at least one from MATH courses numbered 100–189. The second elective may be either an upper-division MATH course or a four-unit upper-division Biological Sciences course with the advanced approval by the advisor for this specialization.	

Sample Program — Mathematics Major Specializing in Mathematical Biology

Freshman		
Fall	**Winter**	**Spring**
MATH 2A	MATH 2B	MATH 2D
BIO SCI 93	BIO SCI 94	MATH 13
General Education	General Education	General Education
General Education	General Education	General Education
Sophomore		
Fall	**Winter**	**Spring**
MATH 2E	MATH 3A	MATH 3D
CHEM 1A	CHEM 1B	General Education/Elective
MATH 9	General Education/Elective	General Education/Elective
General Education/Elective		
Junior		
Fall	**Winter**	**Spring**
MATH 113A	MATH 113B	MATH 115
MATH 105A- 105LA	MATH 105B- 105LB	MATH 121A
General Education/Elective	MATH 140A	MATH 140B
General Education/Elective	General Education/Elective	General Education/Elective
Senior		
Fall	**Winter**	**Spring**
MATH 112A	MATH 112B	MATH 115
MATH 130A	MATH 120A	MATH Elective
Bio. Elective	General Education/Elective	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective

Requirements for Mathematics Major with a Specialization in Mathematics for Education

Admission to this specialization requires approval in advance by the Mathematics Department. The admission process begins with completing a form at the Department office, and includes an interview with the Department's advisor for the specialization. This approval should be applied for no later than the end of the junior year.

This specialization is designed to help prepare students for teaching mathematics. Students wishing to go on and teach at the intermediate and high school levels should also consult with an academic advisor in the School of Education. A Commission on Teacher Credentialing (CTC)-approved subject-matter program (SMP) in Mathematics can be easily satisfied in tandem with this specialization, and enables students to waive a subject matter exam for teachers. Specific SMP requirements and enrollment procedures are available from the School of Education.

Core requirements for all Mathematics majors plus:	
Lower-Division Requirements:	
A. Complete:	
MATH 8	Explorations in Functions and Modeling
Upper-Division Requirements:	
A. Complete:	
MATH 105A- 105LA	Numerical Analysis and Numerical Analysis Laboratory
MATH 120B	Introduction to Abstract Algebra: Rings and Fields
MATH 130B	Probability and Stochastic Processes
MATH 150	Introduction to Mathematical Logic
MATH 161	Modern Geometry
MATH 180A	Number Theory
MATH 184- 184L	History of Mathematics and History of Mathematics Lesson Lab
Plus one additional four-unit MATH course numbered 100–189.	
B. Complete:	
PHY SCI 5	California Teach 1: Introduction to Science and Mathematics Teaching
PHY SCI 105	California Teach 2: Middle School Science and Mathematics Teaching

Sample Program — Mathematics Major Specializing in Mathematics for Education

Freshman		
Fall	**Winter**	**Spring**
MATH 2A	MATH 2B	MATH 2D
PHYSICS 7C- 7LC (or CHEM 1A)	PHYSICS 7D- 7LD (or CHEM 1B)	PHYSICS 7E or CHEM 1C
General Education	MATH 13	General Education
General Education/Elective	General Education	
Sophomore		
Fall	**Winter**	**Spring**
MATH 3A	MATH 3D	MATH 8
PHY SCI 5	PHY SCI 105	MATH 121A
General Education	General Education	MATH 9
General Education		
Junior		
Fall	**Winter**	**Spring**
MATH 130A	MATH 130B	MATH 161
MATH 140A	MATH 120A	MATH 120B
General Education	MATH 140B	General Education/Elective
Senior		
Fall	**Winter**	**Spring**
MATH 105A- 105LA	MATH 180A	MATH 184- 184L
MATH 150	General Education/Elective	General Educaton
General Education/Elective	Math. Elective	General Education

Requirements for Mathematics Major with a Concentration in Mathematics for Education/Secondary Teaching Certification

Admission to this concentration requires approval in advance. The admission process begins with completing an Intent form at the Cal Teach Resource and Advising Center.

Following completion of the Intent form, students must complete an application in the Mathematics Department office and an interview with the Department's advisor for the concentration. These approvals should be applied for no later than the end of the sophomore year.

This concentration allows students pursuing the B.S. in Mathematics to earn a bachelor's degree and complete the required course work and field experience for a California Preliminary Single Subject Teaching Credential at the same time. With careful, early planning, it is possible for students to complete both in four years. For additional information about teacher certification requirements and enrollment procedures, see Preparation for Teaching Science and Mathematics (http://catalogue.uci.edu/schoolofphysicalsciences/#undergraduateprogramstext) or contact the Cal Teach Resource and Advising Center. A Commission on Teacher Credentialing (CTC)-approved subject-matter program (SMP) in Mathematics can be satisfied in tandem with this concentration, and enables students to waive a subject matter exam for teachers. Specific SMP requirements and enrollment procedures are available from the Cal Teach Resource and Advising Center or the School of Education.

Core requirements for all Mathematics majors plus:	
Lower-Division Requirements:	
A. Complete:	
MATH 8	Explorations in Functions and Modeling
Upper-Division Requirements:	
A. Complete:	
MATH 105A- 105LA	Numerical Analysis and Numerical Analysis Laboratory
MATH 120B	Introduction to Abstract Algebra: Rings and Fields
MATH 130B	Probability and Stochastic Processes
MATH 150	Introduction to Mathematical Logic
MATH 161	Modern Geometry
MATH 180A	Number Theory
MATH 184- 184L	History of Mathematics and History of Mathematics Lesson Lab
Plus one addtional four-unit MATH course numbered 100–189.	
B. Complete:	
CHEM 193	Research Methods
or PHYSICS 193	Research Methods
EDUC 55	Knowing and Learning in Mathematics and Science
EDUC 109	Reading and Writing in Secondary Mathematics and Science Classrooms
EDUC 143AW	Classroom Interactions I
EDUC 143BW	Classroom Interactions II
EDUC 148	Complex Pedagogical Design
EDUC 158	Student Teaching Mathematics and Science in Middle/High School (two quarters)
PHY SCI 5	California Teach 1: Introduction to Science and Mathematics Teaching
PHY SCI 105	California Teach 2: Middle School Science and Mathematics Teaching

NOTE: Students may pursue either the concentration in Mathematics for Education/Secondary Teaching Certification or the specialization in Mathematics for Education, but not both.

Sample Program – Concentration in Mathematics for Education/Secondary Teaching Certification

Freshman		
Fall	**Winter**	**Spring**
MATH 2A	MATH 2B	MATH 2D
PHYSICS 7C- 7LC (or CHEM 1A)	PHYSICS 7D- 7LD (or CHEM 1B)	PHYSICS 7E or CHEM 1C
PHY SCI 5	MATH 13	MATH 8
General Education	General Education	MATH 9
Sophomore		
Fall	**Winter**	**Spring**
MATH 3A	MATH 3D	MATH 161
PHY SCI 105	MATH 180A	MATH 121A
General Education	CHEM 193	General Education
Junior		
Fall	**Winter**	**Spring**
MATH 130A	MATH 130B	MATH 184- 184L
MATH 140A	MATH 120A	MATH 120B
EDUC 55	MATH 140B	EDUC 148
	EDUC 143AW	Math. Elective
Senior		
Fall	**Winter**	**Spring**
MATH 105A- 105LA	EDUC 109	EDUC 158
MATH 150	EDUC 158	General Education

EDUC 143BW	General Education	General Education

Additional Information

Honors Program in Mathematics

The Honors Program in Mathematics is designed for students contemplating graduate work in mathematics. The program is open to junior and senior Mathematics majors who meet the minimum academic qualifications of a 3.5 GPA in Mathematics courses and a 3.2 GPA overall. It is highly recommended that students meet with the Honors Advisor by the beginning of their junior year to begin planning courses. Students should officially apply for the Honors Program no later than the Fall quarter of their senior year. Recognition for completing the program is conferred upon graduation.

Participants must meet the following requirements:

A. Complete the requirements for the major in Mathematics (in any one of its tracks)	
B. Complete Math 120B and 121B	
C. Complete one of the following series:	
MATH H140A	Honors Introduction to Graduate Analysis I
MATH H140B	Honors Introduction to Graduate Analysis II
MATH H140C	Honors Introduction to Graduate Analysis III
or	
MATH H120A	Honors Introduction to Graduate Algebra I
MATH H120B	Honors Introduction to Graduate Algebra II
MATH H120C	Honors Introduction to Graduate Algebra III
or	
(MATH 120C or MATH 140C) and MATH 133A - MATH 133B	
or	
(MATH 120C or MATH 140C) and MATH 180A - MATH 180B	
or	
(MATH 120C or MATH 140C) and MATH 113A - MATH 113B	
or	
(MATH 120C or MATH 140C) and MATH 162A - MATH 162B	
D. Complete one quarter of Math 199, or a research project and thesis approved by the Honors Program Advisor.	

These requirements are in addition to the Mathematics major requirements and the requirements for any specialization/concentration. However, MATH H120A-MATH H120B-MATH H120C in item C may be used to satisfy upper-division electives or taken in place of MATH 120A-MATH 120B-MATH 120C and MATH 121A-MATH 121B. Similarly, MATH H140A-MATH H140B-MATH H140C may be used to satisfy upper-division electives or taken in place of MATH 140A-MATH 140B-MATH 140C and MATH 141.

NOTE: If all requirements are completed and the student's work and final GPA satisfies the program restrictions, the student will graduate with Honors in Mathematics, and this distinction is noted on the transcript.

Sample Program — Mathematics Major Honors Program

Freshman		
Fall	**Winter**	**Spring**
MATH 2B	MATH 2D	MATH 2E
PHYSICS 7C- 7LC (or CHEM 1A)	PHYSICS 7D- 7LD (or CHEM 1B)	PHYSICS 7E or CHEM 1C
General Education/Elective	MATH 13	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective
Sophomore		
Fall	**Winter**	**Spring**
MATH 3A	MATH 3D	MATH 121B
General Education/Elective	MATH 121A	General Education/Elective
General Education/Elective	MATH 9	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective
Junior		
Fall	**Winter**	**Spring**
MATH H120A	MATH H120B	MATH H120C
MATH H140A	MATH H140B	MATH H140C
MATH 130A	MATH 147	General Education/Elective
General Education/Elective	General Education/Elective	General Education/Elective

Senior		
Fall	**Winter**	**Spring**
MATH 150	MATH 162A	MATH 162B
General Education/Elective	MATH 199	General Education/Elective
		MATH 199

Research in Mathematics

In order to prepare for independent study/independent research, it is highly recommended that students take at least one course sequence in the field they are interested in studying. The following list contains the major mathematical disciplines and the course work suggested for completion prior to doing independent study in that field:

- Applied Mathematics: MATH 117 and MATH 118
- Algebra: MATH 120A-MATH 120B-MATH 120C
- Probability and Statistics: MATH 130A-MATH 130B-MATH 130C
- Analysis: MATH 140A-MATH 140B-MATH 140C
- Logic: MATH 150
- Geometry: MATH 162A-MATH 162B
- Number Theory: MATH 180A-MATH 180B

Planning a Program of Study

For all Mathematics majors, or prospective majors, assistance in planning a program of study is available from the Mathematics Department Undergraduate Advisor and the advisors for the various tracks, as well as from the academic counselors for the School of Physical Sciences. The application process for the specializations and concentrations requires students to plan a program of study with the assistance of a faculty advisor. The following sample programs are only examples.

Those in the specialization for Education should note that MATH 184 may not be offered more than once every other year and thus should be taken when offered.

Requirements for the Minor in Mathematics

A. Complete:	
MATH 13	Introduction to Abstract Mathematics
MATH 120A	Introduction to Abstract Algebra: Groups
or MATH 140A	Elementary Analysis
B. Select five additional four-unit courses in MATH (plus the associated lab, where applicable) numbered 77–189.	

NOTE: Nearly all upper-division courses in Mathematics have MATH 2A-MATH 2B as prerequisites, and many courses have additional prerequisites such as MATH 2D, MATH 2E, MATH 3A, and/or MATH 3D.

Requirements for the Minor in Mathematics for Biology

A. Complete:	
MATH 13	Introduction to Abstract Mathematics
MATH 113A- 113B	Mathematical Modeling in Biology and Mathematical Modeling in Biology
B. Select two of the following:	
MATH 105A	Numerical Analysis (plus MATH 105LA)
MATH 112A	Introduction to Partial Differential Equations and Applications
MATH 117	Dynamical Systems
MATH 118	The Theory of Differential Equations
MATH 121A	Linear Algebra
MATH 140A	Elementary Analysis
C. One additional four-unit upper-division lecture course in MATH numbered 100–189.	

NOTE: Nearly all upper-division courses in Mathematics have MATH 2A-MATH 2B as prerequisites, and many courses have additional prerequisites such as MATH 2D, MATH 2E, MATH 3A, and/or MATH 3D.

Graduate Program

Graduate courses are designed to meet the needs of students doing graduate work in mathematics and in those disciplines that require graduate-level mathematics for their study. Among the fields covered are analysis, algebra, applied and computational mathematics, mathematical biology, geometry and topology, probability, ordinary and partial differential equations, and mathematical logic.

In addition to formal courses, there are seminars for advanced study toward the Ph.D. in various fields of mathematics. Topics will vary from year to year. Each seminar is conducted by a faculty member specializing in the subject studied. Enrollment will be subject to the approval of the instructor in charge.

Master of Science in Mathematics

To earn the Master of Science degree, the student must satisfy course and residency requirements, and achieve two passes at the M.S. level among three exams in Real Analysis, Complex Analysis, and Algebra prior to the beginning of the second year.

Requirements

The total number of required courses for the M.S. is 12, completed with satisfactory performance, that is, with a grade of B or better. Students are required to complete at least one series of the following courses:

MATH 210A- 210B- 210C	Real Analysis and Real Analysis and Real Analysis
or	
MATH 220A- 220B- 220C	Analytic Function Theory and Analytic Function Theory and Analytic Function Theory
or	
MATH 230A- 230B- 230C	Algebra and Algebra and Algebra

At most one undergraduate course may count as an elective course, provided it is sponsored by rank faculty and approved by the Graduate Advisor. At most one elective course (at least three units) is allowed outside the Department.

To satisfy exam requirements, students may take the Core Assessment Exam (offered in the spring of every year), the Comprehensive Exams (offered in the spring of every year), or the Qualifying Exams (offered before the start of each fall quarter) in Real Analysis, Complex Analysis, and Algebra. Students may not attempt to pass an exam in any particular area more than three times. Some students may require additional background before entering MATH 210 or MATH 230. This will be determined by assessment prior to the start of the students' first year by the Vice Chair of Graduate Studies, upon consultation with the Graduate Studies Committee. Such students will be directed into MATH 205 and/or MATH 206 during their first year. They may pass one Comprehensive Exam in the areas of Analysis or Algebra in lieu of achieving an M.S. pass in one of the Core Assessment or Qualifying Exams that must be obtained prior to the start of their second year.

Students who fail to pass the required examinations satisfactorily within the period specified will be recommended for academic disqualification by the Graduate Dean.

MATH 199, MATH 297, MATH 298, MATH 299, and may not be used to fulfill course requirements.

The residency requirement ordinarily is satisfied by full-time enrollment for three quarters immediately preceding the award of the M.S. When appropriate, a leave of absence may be granted between matriculation and the final quarters of study.

If the candidate is not advanced before the beginning of the quarter in which all requirements are completed, the degree will not be conferred until the end of the following quarter. Deadlines for submission of the Application for Advancement to Candidacy are published on the Graduate Division website (http://www.grad.uci.edu/academics/filing%20deadlines) under filing fees and deadlines.

Advancement to M.S. Candidacy

All Master’s students must be advanced to candidacy for the degree prior to the beginning of their final quarter of enrollment. An application for Advancement to Candidacy must be completed by the student and submitted for approval to the Department. The approved application must be submitted to the Graduate Division by the deadline published on the Graduate Division website (http://www.grad.uci.edu). Advancement to M.S.Candidacy must occur one quarter prior to the degree conferral quarter.

Filing fee information can be located on the Graduate Division website (http://www.grad.uci.edu).

Master of Science in Mathematics with a Teaching Credential

In cooperation with the UCI School of Education, the Department of Mathematics sponsors a coordinated program for the M.S. degree in Mathematics and the California Single Subject Teaching Credential. The requirements for this option are the same as the Master of Science in Mathematics requirements listed above.

The student will complete the requirements for the Master's degree with the Mathematics Department (generally a two-year commitment) and then will petition with the UCI School of Education to take the School of Education's credential courses (generally a one-year commitment). The student must meet the requirements of the School of Education for the CBEST, CSET, TB test, and Certificate of Clearance. Prospective graduate students interested in this program should so indicate on their applications. A detailed description of the program can be requested from the School of Education.

Doctor of Philosophy in Mathematics

When accepted into the doctoral program, the student embarks on a program of formal courses, seminars, and individual study courses to prepare for the Ph.D. written examinations, Advancement to Candidacy examination, and dissertation.

Requirements

Upon entering the program, students are expected to take MATH 210A, MATH 210B, MATH 210C, MATH 220A, MATH 220B, MATH 220C, MATH 230A, MATH 230B, and MATH 230C, which must be passed with a grade of B or better. Students must complete these sequences by the end of the second year.

By the start of the second year, students must achieve at least two passes at the M.S. level among three exams in Real Analysis, Complex Analysis, and Algebra. By the start of the third year, students must achieve two Ph.D. level passes among three exams in Real Analysis, Complex Analysis, and Algebra.

To satisfy the exam requirements, students may take the Core Assessment Exams (offered in spring of every year) or the Qualifying Exams (offered before the start of the fall quarter) in these areas. Students may not attempt to take an exam in a particular subject area more than three times. A student who passes a Qualifying Examination at the Ph.D. level prior to taking the corresponding course will be exempted from taking the course.

Some students may require additional background prior to entering MATH 210A, MATH 210B, MATH 210C, MATH 230A, MATH 230B, and MATH 230C. This will be determined by assessment prior to the start of the students' first year by the Vice Chair for Graduate Studies, upon consultation with the Graduate Studies Committee. Such students will be directed into MATH 205 and/or MATH 206, or equivalent, during their first year. These students may pass one Comprehensive Exam in the areas of Algebra or Analysis in lieu of achieving an M.S. pass on one Core Assessment or Qualifying Exam that must be obtained prior to the start of the students' second year. Comprehensive Exams in Analysis and Algebra will be offered once per year in the spring quarter.

By the end of their second year, students must declare a major specialization from the following areas: Algebra, Analysis, Applied and Computational Mathematics, Geometry and Topology, Logic, or Probability. Students are required to take two series of courses from their chosen area. (Students who later decide to change their area must also take two series of courses from the new area.) Additionally, all students must take two series outside their declared major area of specialization. Special topics courses within certain areas of specialization and courses counted toward the M.S., other than MATH 205A-MATH 205B-MATH 205C and MATH 206A-MATH 206B-MATH 206C, will count toward the fulfillment of the major specialization requirement.

By the beginning of their third year, students must have an advisor specializing in their major area. With the advisor's aid, the student forms a committee for the Advancement to Candidacy oral examination. This committee will be approved by the Department on behalf of the Dean of the Graduate Division and the Graduate Council and will consist of five faculty members. At least one, and at most two, of the members must be faculty from outside the Department. Before the end of the third year, students must have a written proposal, approved by their committee, for the Advancement to Candidacy examination. The proposal should explain the role of at least two series of courses from the student's major area of specialization that will be used to satisfy the Advancement to Candidacy requirements. The proposal should also explain the role of additional research reading material as well as providing a plan for investigating specific topics under the direction of the student's advisor(s). Only one of the courses MATH 210A-MATH 210B-MATH 210C, MATH 220A-MATH 220B-MATH 220C, and MATH 230A-MATH 230B-MATH 230C may count for the course requirement for Advancement to Candidacy Examinations. After the student meets the requirements, the Graduate Studies Committee recommends to the Dean of the Graduate Division the advancement to candidacy for the Ph.D. Students should advance to candidacy by the beginning of their fourth year.

After advancing to candidacy, students are expected to be fully involved in research toward writing their Ph.D. dissertation. Ideally, students should keep in steady contact/interaction with their Doctoral Committee.

Teaching experience and training is an integral part of the Ph.D. program. All doctoral students are expected to participate in the Department's teaching program.

The candidate must demonstrate independent, creative research in Mathematics by writing and defending a dissertation that makes a new and valuable contribution to mathematics in the candidate's area of concentration. Upon Advancement to Candidacy a student must form a Thesis Committee, a subcommittee of the Advancement Examination Committee, consisting of at least three faculty members and chaired by the student's advisor. The committee guides and supervises the candidate's research, study, and writing of the dissertation; conducts an oral defense of the dissertation; and recommends that the Ph.D. be conferred upon approval of the Doctoral Dissertation. The normative time for completion of the Ph.D. is six years, and the maximum time permitted is seven years. Completion of the Ph.D. degree must occur within nine quarters of Advancement to Ph.D. candidacy.

Examinations

Ph.D. examinations are given in Algebra, Complex Analysis, and Real Analysis. All students seeking the Ph.D. must successfully complete two examinations before the end of the third year of entering the graduate program. Only two attempts are allowed for a Ph.D. student on each exam.

Area Requirements

Ph.D. students will choose from one of six areas of specialization in the Mathematics Department, which determines course work requirements. Each area of specialization will have a core course, which the Department will do its best to offer each year. The Department will offer other courses every other year, or more frequently depending on student demands and other Department priorities.

Algebra	
MATH 230A- 230B- 230C	Algebra and Algebra and Algebra (core)
MATH 232A- 232B- 232C	Algebraic Number Theory and Algebraic Number Theory and Algebraic Number Theory
MATH 233A- 233B- 233C	Algebraic Geometry and Algebraic Geometry and Algebraic Geometry
MATH 235A	Mathematics of Cryptography
Analysis	
MATH 210A- 210B- 210C	Real Analysis and Real Analysis and Real Analysis (core)
MATH 211C	Topics in Analysis
MATH 220A- 220B- 220C	Analytic Function Theory and Analytic Function Theory and Analytic Function Theory (core)
MATH 260A- 260B- 260C	Functional Analysis and Functional Analysis and Functional Analysis
MATH 295A- 295B- 295C	Partial Differential Equations and Partial Differential Equations and Partial Differential Equations
MATH 296	Topics in Partial Differential Equations
Applied and Computational Mathematics	
MATH 290A- 290B- 290C	Methods in Applied Mathematics and Methods in Applied Mathematics and Methods in Applied Mathematics (core)
MATH 225A- 225B- 225C	Introduction to Numerical Analysis and Scientific Computing and Introduction to Numerical Analysis and Scientific Computing and Introduction to Numerical Analysis and Scientific Computing
MATH 226A- 226B- 226C	Computational Differential Equations and Computational Differential Equations and Computational Differential Equations
MATH 227A- 227B	Mathematical and Computational Biology and Mathematical and Computational Biology
MATH 295A- 295B- 295C	Partial Differential Equations and Partial Differential Equations and Partial Differential Equations
Geometry and Topology	
MATH 218A- 218B- 218C	Introduction to Manifolds and Geometry and Introduction to Manifolds and Geometry and Introduction to Manifolds and Geometry (core)
MATH 222A	Several Complex Variables and Complex Geometry

MATH 240A- 240B- 240C	Differential Geometry and Differential Geometry and Differential Geometry
MATH 245A- 245C- 245C	Topics in Differential Geometry and Topics in Differential Geometry and Topics in Differential Geometry
MATH 250A- 250B- 250C	Algebraic Topology and Algebraic Topology and Algebraic Topology
Logic	
MATH 280A- 280B- 280C	Mathematical Logic and Mathematical Logic and Mathematical Logic (core)
MATH 281A- 281B- 281C	Set Theory and Set Theory and Set Theory
MATH 282A- 282B- 282C	Model Theory and Model Theory and Model Theory
MATH 285A- 285B- 285C	Topics in Mathematical Logic and Topics in Mathematical Logic and Topics in Mathematical Logic
Probability	
MATH 210A- 210B- 210C	Real Analysis and Real Analysis and Real Analysis
MATH 211C	Topics in Analysis
MATH 270A- 270B- 270C	Probability and Probability and Probability (core)
MATH 271A- 271B- 271C	Stochastic Processes and Stochastic Processes and Stochastic Processes (core)
MATH 274	Topics in Probability

Graduate Program in Mathematical, Computational, and Systems Biology

The graduate program in Mathematical, Computational, and Systems Biology (MCSB) is designed to meet the interdisciplinary training challenges of modern biology and function in concert with selected department programs, including the Ph.D. in Mathematics. Detailed information is available at the Mathematical, Computational, and Systems Biology website (http://mcsb.uci.edu) and in the Interdisciplinary Studies section (http://catalogue.uci.edu/interdisciplinarystudies/gradprograminmathematicalcomputationalandsystemsbiology) of the *Catalogue*.

Faculty

Takeo Akasaki, Ph.D. University of California, Los Angeles, *Professor Emeritus of Mathematics* (ring theory)

Jun F. Allard, Ph.D. University of British Columbia, *Assistant Professor of Mathematics; Physics and Astronomy* (mathematical and computational biology)

Pierre F. Baldi, Ph.D. California Institute of Technology, *UCI Chancellor's Professor of Computer Science; Biological Chemistry; Biomedical Engineering; Developmental and Cell Biology; Mathematics* (bioinformatics, computational biology)

Vladimir Baranovsky, Ph.D. University of Chicago, *Associate Professor of Mathematics* (algebra and number theory)

Frank B. Cannonito, Ph.D. Adelphi University, *Professor Emeritus of Mathematics* (group theory)

Long Chen, Ph.D. Pennsylvania State University, *Professor of Mathematics* (applied and computational mathematics)

Michael C. Cranston, Ph.D. University of Minnesota, *Professor of Mathematics* (probability)

Donald A. Darling, Ph.D. California Institute of Technology, *Professor Emeritus of Mathematics*

Christopher J. Davis, Ph.D. Massachusetts Institute of Technology, *Lecturer with Potential Security of Employment of Mathematics* (algebra and number theory)

Neil Donaldson, Ph.D. University of Bath, *Lecturer of Mathematics* (differential geometry)

Paul C. Eklof, Ph.D. Cornell University, *Professor Emeritus of Mathematics* (logic and algebra)

German A. Enciso Ruiz, Ph.D. Rutgers, the State University of New Jersey, *Associate Professor of Mathematics; Developmental and Cell Biology* (applied and computational mathematics, mathematical and computational biology)

Aleksandr Figotin, Ph.D. Tashkent University of Information Technologies, *Professor of Mathematics* (applied and computational mathematics, mathematical physics)

Mark Finkelstein, Ph.D. Stanford University, *Professor Emeritus of Mathematics; Center for Educational Partnerships* (analysis)

Matthew Foreman, Ph.D. University of California, Berkeley, *Professor of Mathematics; Logic and Philosophy of Science* (ergodic theory and dynamical systems, logic and foundations)

Michael D. Fried, Ph.D. University of Michigan, *Professor Emeritus of Mathematics* (arithmetic geometry and complex variables)

Isaac Goldbring, Ph.D. University of Illinois at Urbana-Champaign, *Assistant Professor of Mathematics* (logic and foundations)

Anton Gorodetski, Ph.D. Moscow State University, *Professor of Mathematics* (ergodic theory and dynamical systems)

Patrick Q. Guidotti, Ph.D. University of Zurich, *Professor of Mathematics* (analysis and partial differential equations, applied and computational mathematics)

Hamid Hezari, Ph.D. Johns Hopkins University, *Assistant Professor of Mathematics* (analysis and partial differential equations)

Svetlana Jitomirskaya, Ph.D. Moscow State University, *Professor of Mathematics* (mathematical physics)

Nathan Kaplan, Ph.D. Harvard University, *Assistant Professor of Mathematics* (algebra and number theory)

Abel Klein, Ph.D. Massachusetts Institute of Technology, *Professor of Mathematics* (mathematical physics)

Natalia Komarova, Ph.D. University of Arizona, *UCI Chancellor's Professor of Mathematics; Ecology and Evolutionary Biology* (applied and computational mathematics, mathematical and computational biology, mathematics of complex and social phenomena)

Jason Russell Kronewetter, Ph.D. University of California, Irvine, *Lecturer of Mathematics*

Katsiaryna Krupchyk, Ph.D. Belarusian State University, *Associate Professor of Mathematics* (analysis and partial differential equations, inverse problems)

Rachel Lehman, Ph.D. University of California, Irvine, *Lecturer of Mathematics* (mathematics education and probability)

Peter Li, Ph.D. University of California, Berkeley, *Professor Emeritus of Mathematics* (geometry and topology)

Song-Ying Li, Ph.D. University of Pittsburgh, *Professor of Mathematics* (analysis and partial differential equations)

John S. Lowengrub, Ph.D. Courant Institute of Mathematical Sciences, *UCI Chancellor's Professor of Mathematics; Biomedical Engineering; Chemical Engineering and Materials Science* (applied and computational mathematics, mathematical and computational biology)

Zhiqin Lu, Ph.D. Courant Institute of Mathematical Sciences, *Professor of Mathematics* (geometry and topology)

Penelope J. Maddy, Ph.D. Princeton University, *UCI Distinguished Professor of Logic and Philosophy of Science; Mathematics; Philosophy* (philosophy of mathematics and logic, meta-philosophy)

Eric D. Mjolsness, Ph.D. California Institute of Technology, *Professor of Computer Science; Mathematics* (applied mathematics, mathematical biology, modeling languages)

Qing Nie, Ph.D. Ohio State University, *Director of Center for Mathematical and Computational Biology and UCI Chancellor's Professor of Mathematics; Biomedical Engineering* (computational mathematics, systems biology, cell signaling, stem cell)

Alessandra Pantano, Ph.D. Princeton University, *Lecturer with Security of Employment of Mathematics* (algebra and number theory)

David L. Rector, Ph.D. Massachusetts Institute of Technology, *Professor Emeritus of Mathematics* (algebraic topology and computer algebra)

Robert C. Reilly, Ph.D. University of California, Berkeley, *Professor Emeritus of Mathematics* (geometry and topology)

Karl Rubin, Ph.D. Harvard University, *Edward and Vivian Thorp Chair in Mathematics and Professor of Mathematics* (algebra and number theory)

Bernard Russo, Ph.D. University of California, Los Angeles, *Professor Emeritus of Mathematics* (functional analysis)

Donald G. Saari, Ph.D. Purdue University, *UCI Distinguished Professor Emeritus of Economics; Logic and Philosophy of Science; Mathematics*

Martin Schechter, Ph.D. New York University, *Professor Emeritus of Mathematics* (analysis and partial differential equations, mathematical physics)

Stephen Scheinberg, Ph.D. Princeton University, *Professor Emeritus of Mathematics*

Richard M. Schoen, Ph.D. Stanford University, *UCI Excellence in Teaching Chair in Mathematics and Professor of Mathematics* (differential geometry, partial differential equations, general relativity)

Alice Silverberg, Ph.D. Princeton University, *Professor of Mathematics; Computer Science* (algebra and number theory)

William H. Smoke, Ph.D. University of California, Berkeley, *Professor Emeritus of Mathematics* (homological algebra)

Knut Solna, Ph.D. Stanford University, *Professor of Mathematics* (applied and computational mathematics, inverse problems and imaging, probability)

Ronald J. Stern, Ph.D. University of California, Los Angeles, *Professor Emeritus of Mathematics* (geometry and topology)

Jeffrey D. Streets, Ph.D. Duke University, *Associate Professor of Mathematics* (geometry and topology)

Chuu-Lian Terng, Ph.D. Brandeis University, *Professor Emerita of Mathematics* (differential geometry and integrable systems)

Edriss S. Titi, Ph.D. Indiana University, *Professor Emeritus of Mathematics* (analysis and partial differential equations, applied and computational mathematics)

Thomas Trogdon, Ph.D. University of Washington, *Assistant Professor of Mathematics* (applied and computational mathematics, probability)

Li Sheng Tseng, Ph.D. University of Chicago, *Associate Professor of Mathematics* (geometry and topology, mathematical physics)

Howard G. Tucker, Ph.D. University of California, Berkeley, *Professor Emeritus of Mathematics* (probability and statistics)

Roman Vershynin, Ph.D. University of Missouri-Columbia, *Professor of Mathematics* (probability, data science)

Jeffrey Viaclovsky, Ph.D. Princeton University, *Professor of Mathematics* (differential geometry, geometric analysis)

Daqing Wan, Ph.D. University of Washington, *Professor of Mathematics* (algebra and number theory)

Frederic Yui-Ming Wan, Ph.D. Massachusetts Institute of Technology, *Professor Emeritus of Mathematics; Mechanical and Aerospace Engineering* (applied and computational mathematics, mathematical and computational biology)

Robert W. West, Ph.D. University of Michigan, *Professor Emeritus of Mathematics* (algebraic toplogy)

Joel J. Westman, Ph.D. University of California, Los Angeles, *Professor Emeritus of Mathematics* (analysis)

Robert J. Whitley, Ph.D. New Mexico State University, *Professor Emeritus of Mathematics* (analysis)

Janet L. Williams, Ph.D. Brandeis University, *Professor Emerita of Mathematics* (probability and statistics)

Dominik Franz X. Wodarz, Ph.D. Oxford University, *Professor of Ecology and Evolutionary Biology; Mathematics*

Jesse Wolfson, Ph.D. Northwestern University, *Assistant Professor of Mathematics* (topology)

Jack Xin, Ph.D. New York University, *Professor of Mathematics* (applied and computational mathematics, mathematical and computational biology, probability)

James J. Yeh, Ph.D. University of Minnesota, *Professor Emeritus of Mathematics* (analysis and partial differential equations, probability)

Yifeng Yu, Ph.D. University of California, Berkeley, *Professor of Mathematics* (analysis and partial differential equations)

Martin Zeman, Ph.D. Humboldt University of Berlin, *Professor of Mathematics; Logic and Philosophy of Science* (logic and foundations)

Xiangwen Zhang, Ph.D. McGill University, *Assistant Professor of Mathematics* (geometry and topology)

Hong-Kai Zhao, Ph.D. University of California, Los Angeles, *Department Chair and Chancellor's Professor of Mathematics; Computer Science* (applied and computational mathematics, inverse problems and imaging)

Weian Zheng, Ph.D. University of Strasbourg, *Professor Emeritus of Mathematics* (probability theory and financial engineering)

Courses

MATH 1A. Pre-Calculus. 4 Workload Units.
Basic equations and inequalities, linear and quadratic functions, and systems of simultaneous equations.

Grading Option: Workload Credit Letter Grade with P/NP.

MATH 1B. Pre-Calculus. 4 Units.
Preparation for calculus and other mathematics courses. Exponentials, logarithms, trigonometry, polynomials, and rational functions. Satisfies no requirements other than contribution to the 180 units required for graduation.

Prerequisite: MATH 1A. Placement into MATH 1B via the Calculus Placement exam, or a score of 450 or higher on the Mathematics section of the SAT Reasoning Test.

Restriction: MATH 1B may not be taken for credit if taken after MATH 2A.

MATH 2A. Single-Variable Calculus. 4 Units.
Introduction to derivatives, calculation of derivatives of algebraic and trigonometric functions; applications including curve sketching, related rates, and optimization. Exponential and logarithm functions.

Prerequisite: MATH 1B or AP Calculus AB or SAT Mathematics or ACT Mathematics. MATH 1B with a grade of C or better. AP Calculus AB with a minimum score of 3. SAT Mathematics with a minimum score of 650. ACT Mathematics with a minimum score of 29. Placement via the Calculus Placement exam (fee required) is also accepted.

Overlaps with MATH 5A.

Restriction: School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. School of Info & Computer Sci students have first consideration for enrollment.

(Vb)

MATH 2B. Single-Variable Calculus. 4 Units.
Definite integrals; the fundamental theorem of calculus. Applications of integration including finding areas and volumes. Techniques of integration. Infinite sequences and series.

Prerequisite: MATH 2A or MATH 5A or AP Calculus AB or AP Calculus BC. AP Calculus AB with a minimum score of 4. AP Calculus BC with a minimum score of 3

Restriction: School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. School of Info & Computer Sci students have first consideration for enrollment.

(Vb)

MATH 2D. Multivariable Calculus. 4 Units.
Differential and integral calculus of real-valued functions of several real variables, including applications. Polar coordinates.

Prerequisite: MATH 2B or MATH 5B or AP Calculus BC. AP Calculus BC with a minimum score of 4

Restriction: School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. School of Info & Computer Sci students have first consideration for enrollment. Undeclared Majors have first consideration for enrollment.

(Vb)

MATH 2E. Multivariable Calculus. 4 Units.
The differential and integral calculus of vector-valued functions. Implicit and inverse function theorems. Line and surface integrals, divergence and curl, theorems of Greens, Gauss, and Stokes.

Prerequisite: MATH 2D or MATH H2D

Restriction: School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment.

MATH H2D. Honors Multivariable Calculus. 4 Units.
Differential and integral calculus of real-valued functions of several real variables, including applications. Polar coordinates. Covers the same material as MATH 2D-E, but with a greater emphasis on the theoretical structure of the subject matter.

Prerequisite: MATH 2B or MATH 5B or (AP Calculus BC and (MATH H3A) or (MATH 3A and MATH 13)). MATH 2B with a grade of A or better. MATH 5B with a grade of A or better. AP Calculus BC with a minimum score of 5. MATH H3A with a grade of B- or better. MATH 3A with a grade of A or better. MATH 13 with a grade of A or better

Overlaps with MATH 2D.

(Vb)

MATH H2E. Honors Multivariable Calculus. 4 Units.
Differential and integral calculus of real-valued functions of several real variables, including applications. Polar coordinates. Covers the same material as MATH 2D-E, but with a greater emphasis on the theoretical structure of the subject matter.

Prerequisite: MATH H2D. MATH H2D with a grade of B- or better

Overlaps with MATH 2E.

MATH 3A. Introduction to Linear Algebra. 4 Units.
Systems of linear equations, matrix operations, determinants, eigenvalues and eigenvectors, vector spaces, subspaces, and dimension.

Prerequisite: MATH 2B or MATH 5B or AP Calculus BC. AP Calculus BC with a minimum score of 4

Overlaps with MATH 6G, I&C SCI 6N.

Restriction: School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment. Undeclared Majors have first consideration for enrollment.

(Vb)

MATH 3D. Elementary Differential Equations. 4 Units.
Linear differential equations, variation of parameters, constant coefficient cookbook, systems of equations, Laplace tranforms, series solutions.

Prerequisite: (MATH 3A or MATH H3A) and (MATH 2D or MATH H2D) and (MATH 2B or AP Calculus BC). AP Calculus BC with a minimum score of 4

Restriction: School of Physical Sciences students have first consideration for enrollment. School of Engineering students have first consideration for enrollment.

MATH H3A. Honors Introduction to Linear Algebra. 4 Units.
Systems of linear equations, matrix operations, determinants, eigenvalues, eigenvectors, vector spaces, subspaces, and dimension.

Prerequisite: MATH 2B or MATH 5B or AP Calculus BC. MATH 2B with a grade of A or better. MATH 5B with a grade of A or better. AP Calculus BC with a minimum score of 5

Overlaps with MATH 6G, MATH 3A, I&C SCI 6N.

Restriction: School of Physical Sciences students only. School of Engineering students only. Mathematics Majors only. Undeclared Majors only.

MATH 4. Mathematics for Economists. 4 Units.
Topics in linear algebra and multivariable differential calculus suitable for economic applications.

Prerequisite: MATH 2B or MATH 5B or AP Calculus BC. AP Calculus BC with a minimum score of 4

Overlaps with MATH 2D, MATH H2D, MATH 3A, MATH H3A.

(Vb)

MATH 5A. Calculus for Life Sciences. 4 Units.
Differential calculus with applications to life sciences. Exponential, logarithmic, and trigonometric functions. Limits, differentiation techniques, optimization and difference equations.

Prerequisite: MATH 1B or AP Calculus AB or SAT Mathematics or ACT Mathematics. MATH 1B with a grade of C or better. AP Calculus AB with a minimum score of 3. SAT Mathematics with a minimum score of 650. ACT Mathematics with a minimum score of 29. Placement via the Calculus Placement exam (fee required) is also accepted.

Overlaps with MATH 2A.

Restriction: School of Biological Sciences students have first consideration for enrollment.

(Vb)

MATH 5B. Calculus for Life Sciences. 4 Units.
Integral calculus and multivariable calculus with applications to life sciences. Integration techniques, applications of the integral, phase plane methods and basic modeling, basic multivariable methods.

Prerequisite: MATH 5A or MATH 2A or AP Calculus AB or AP Calculus BC. AP Calculus AB with a minimum score of 4. AP Calculus BC with a minimum score of 3

Restriction: School of Biological Sciences students have first consideration for enrollment. Cannot be taken for credit after MATH 2B.

(Vb)

MATH 7A. Single-Variable Calculus I. 4 Units.
Introduction to derivatives, calculation of derivatives of algebraic and trigonometric functions; applications including curve sketching, related rates, and optimization. Exponential and logarithm functions.

Prerequisite: MATH 1B or AP Calculus AB or SAT Mathematics or ACT Mathematics. MATH 1B with a grade of C or better. AP Calculus AB with a minimum score of 3. SAT Mathematics with a minimum score of 650. ACT Mathematics with a minimum score of 29. Placement via the Calculus Placement exam (fee required) is also accepted.

Overlaps with MATH 2A, MATH 5A.

Restriction: Mathematics Majors only.

(Vb)

MATH 7B. Single-Variable Calculus II. 4 Units.
Definite integrals; the fundamental theorem of calculus. Applications of integration including finding areas and volumes. Techniques of integration. Infinite sequences and series.

Prerequisite: MATH 2A or MATH 5A or AP Calculus AB or AP Calculus BC or MATH 7A. AP Calculus AB with a minimum score of 4. AP Calculus BC with a minimum score of 3

Overlaps with MATH 2B, MATH 5B.

Restriction: Mathematics Majors only.

(Vb)

MATH 8. Explorations in Functions and Modeling. 4 Units.
Explorations of applications and connections in topics in algebra, geometry, calculus, and statistics for future secondary math educators. Emphasis on nonstandard modeling problems.

Prerequisite or corequisite: MATH 2A or AP Calculus AB or AP Calculus BC. AP Calculus AB with a minimum score of 4. AP Calculus BC with a minimum score of 3

MATH 9. Introduction to Programming for Numerical Analysis. 4 Units.
Introduction to computers and programming using Matlab and Mathematica. Representation of numbers and precision, input/output, functions, custom data types, testing/debugging, reading exceptions, plotting data, numerical differentiation, basics of algorithms. Analysis of random processes using computer simulations.

Prerequisite: MATH 2A

Restriction: Mathematics Majors have first consideration for enrollment.

(II and Vb).

MATH 10. Introduction to Programming for Data Science. 4 Units.
Intro to algorithms in data science using Python and R. Basic concepts of Python, store, access and manipulate data in lists, functions, methods and packages, NumPy, Numerical stability and accuracy. Gradient descent and Newton's method. Basic of R Programming.

Prerequisite or corequisite: (MATH 2D or MATH H2D) and (MATH 3A or MATH H3A) and MATH 9

Restriction: Mathematics Majors have first consideration for enrollment.

Concurrent with MATH 3A.

(II and VB).

MATH 13. Introduction to Abstract Mathematics. 4 Units.
Introduction to formal definition and rigorous proof writing in mathematics. Topics include basic logic, set theory, equivalence relations, and various proof techniques such as direct, induction, contradiction, contrapositive, and exhaustion.

Prerequisite: MATH 2A or I&C SCI 6D

Restriction: Mathematics Majors have first consideration for enrollment.

MATH 105A. Numerical Analysis. 4 Units.
Introduction to the theory and practice of numerical computation. Floating point arithmetic, roundoff; solving transcendental equations; quadrature; linear systems, eigenvalues, power method.

Corequisite: MATH 105LA
Prerequisite: MATH 3A or MATH H3A. Familiarity with computer programming is required.

Overlaps with ENGRMAE 185.

MATH 105B. Numerical Analysis. 4 Units.
Introduction to the theory and practice of numerical computation. Lagrange interpolation, finite differences, splines, Padé approximations; Gaussian quadrature; Fourier series and transforms.

Corequisite: MATH 105LB
Prerequisite: MATH 105A

MATH 105LA. Numerical Analysis Laboratory. 1 Unit.
Provides practical experience to complement the theory developed in Mathematics 105A.

Corequisite: MATH 105A

MATH 105LB. Numerical Analysis Laboratory. 1 Unit.
Provides practical experience to complement the theory developed in Mathematics 105B.

Corequisite: MATH 105B

MATH 107. Numerical Differential Equations. 4 Units.
Theory and applications of numerical methods to initial and boundary-value problems for ordinary and partial differential equations.

Corequisite: MATH 107L
Prerequisite: MATH 3D and MATH 105A and MATH 105B

MATH 107L. Numerical Differential Equations Laboratory. 1 Unit.
Provides practical experience to complement the theory developed in Mathematics 107.

Corequisite: MATH 107

MATH 110A. Optimization I. 4 Units.
Introduction to optimization, linear search method, trust region method, Newton method, linear programming, linear, and non-linear least square methods.

Prerequisite: (MATH 2D or MATH H2D) and (MATH 3A or MATH H3A) and MATH 10

MATH 110B. Optimization II. 4 Units.
The simplex method, interior point method, penalty barrier method, primal dual method, augmented Lagrangian method, and stochastic gradient method.

Prerequisite: MATH 110A. MATH 110A with a grade of C or better

Restriction: Mathematics Majors have first consideration for enrollment.

MATH 112A. Introduction to Partial Differential Equations and Applications. 4 Units.
Introduction to ordinary and partial differential equations and their applications in engineering and science. Basic methods for classical PDEs (potential, heat, and wave equations). Classification of PDEs, separation of variables and series expansions, special functions, eigenvalue problems.

Prerequisite: (MATH 2E or MATH H2E) and MATH 3D

MATH 112B. Introduction to Partial Differential Equations and Applications. 4 Units.
Introduction to partial differential equations and their applications in engineering and science. Basic methods for classical PDEs (potential, heat, and wave equations). Green functions and integral representations, method of characteristics.

Prerequisite: MATH 112A

MATH 112C. Introduction to Partial Differential Equations and Applications. 4 Units.
Nonhomogeneous problems and Green's functions, Sturm-Liouville theory, general Fourier expansions, applications of partial differential equations in different areas of science.

Prerequisite: MATH 112B

MATH 113A. Mathematical Modeling in Biology. 4 Units.
Discrete mathematical and statistical models; difference equations, population dynamics, Markov chains, and statistical models in biology.

Prerequisite: MATH 2B or MATH 5B

MATH 113B. Mathematical Modeling in Biology. 4 Units.
Linear algebra; differential equations models; dynamical systems; stability; hysteresis; phase plane analysis; applications to cell biology, viral dynamics, and infectious diseases.

Prerequisite: MATH 2B or AP Calculus BC or MATH 5B. AP Calculus BC with a minimum score of 4

MATH 115. Mathematical Modeling. 4 Units.
Mathematical modeling and analysis of phenomena that arise in engineering physical sciences, biology, economics, or social sciences.

Prerequisite: MATH 112A and (MATH 2D or MATH H2D) and (MATH 3A or MATH H3A) and MATH 3D

MATH 117. Dynamical Systems. 4 Units.
Introduction to the modern theory of dynamical systems including contraction mapping principle, fractals and chaos, conservative systems, Kepler problem, billiard models, expanding maps, Smale's horseshoe, topological entropy.

Prerequisite: MATH 3D and MATH 140A

MATH 118. The Theory of Differential Equations. 4 Units.
Existence and uniqueness of solutions, continuous dependence of solutions on initial conditions and parameteres, Lyapunov and asymptotic stability, Floquet theory, nonlinear systems, and bifurcations.

Prerequisite: MATH 3D and MATH 140A

MATH 120A. Introduction to Abstract Algebra: Groups. 4 Units.
Axioms for group theory; permutation groups, matrix groups. Isomorphisms, homomorphisms, quotient groups. Advanced topics as time permits. Special emphasis on doing proofs.

Prerequisite: (MATH 3A or MATH H3A) and MATH 13. MATH 13 with a grade of C or better

Restriction: Mathematics Majors have first consideration for enrollment.

MATH 120B. Introduction to Abstract Algebra: Rings and Fields. 4 Units.
Basic properties of rings; ideals, quotient rings; polynomial and matrix rings. Elements of field theory.

Prerequisite: MATH 120A. MATH 120A with a grade of C- or better

Restriction: Mathematics Majors have first consideration for enrollment.

MATH 120C. Introduction to Abstract Algebra: Galois Theory. 4 Units.
Galois Theory: proof of the impossibility of certain ruler-and-compass constructions (squaring the circle, trisecting angles); nonexistence of analogues to the "quadratic formula" for polynomial equations of degree 5 or higher.

Prerequisite: MATH 120B

Restriction: Mathematics Majors have first consideration for enrollment.

MATH H120A. Honors Introduction to Graduate Algebra I. 5 Units.
Introduction to abstract linear algebra, including bases, linear transformation, eigenvectors, canonical forms, inner products, and symmetric operators. Introduction to groups, rings, and fields, including examples of groups, group actions, Sylow theorems, modules over principal ideal domains, polynomials, and Galois groups.

Prerequisite: (MATH 3A or MATH H3A) and MATH 13 and (MATH 120A or MATH 121A). MATH 13 with a grade of A or better. MATH 120A with a grade of A or better. MATH 121A with a grade of A or better

Restriction: Mathematics Honors students only.

Concurrent with MATH 206A.

MATH H120B. Honors Introduction to Graduate Algebra II. 5 Units.
Introduction to abstract linear algebra, including bases, linear transformation, eigenvectors, canonical forms, inner products, and symmetric operators. Introduction to groups, rings, and fields, including examples of groups, group actions, Sylow theorems, modules over principal ideal domains, polynomials, and Galois groups.

Prerequisite: MATH H120A

Restriction: Mathematics Honors students only.

Concurrent with MATH 206B.

MATH H120C. Honors Introduction to Graduate Algebra III. 5 Units.
Introduction to abstract linear algebra, including bases, linear transformation, eigenvectors, canonical forms, inner products, and symmetric operators. Introduction to groups, rings, and fields, including examples of groups, group actions, Sylow theorems, modules over principal ideal domains, polynomials, and Galois groups.

Prerequisite: MATH H120B

Restriction: Mathematics Honors students only.

Concurrent with MATH 206C.

MATH 121A. Linear Algebra. 4 Units.
Introduction to modern abstract linear algebra. Special emphasis on students doing proofs. Vector spaces, linear independence, bases, dimension. Linear transformations and their matrix representations. Theory of determinants.

Prerequisite: (MATH 3A or MATH H3A) and MATH 13. MATH 13 with a grade of C or better

Restriction: Mathematics Majors have first consideration for enrollment.

MATH 121B. Linear Algebra. 4 Units.
Introduction to modern abstract linear algebra. Special emphasis on students doing proofs. Canonical forms; inner products; similarity of matrices.

Prerequisite: MATH 121A

Restriction: Mathematics Majors have first consideration for enrollment.

MATH 130A. Probability and Stochastic Processes. 4 Units.
Basic concepts of random variables, distributions, independence, correlations, moments, limit theorems, conditional probability, Markov chains, gambler's ruin, branching process, birth and death processes, numerical simulations in Matlab.

Prerequisite: (MATH 2A or AP Calculus BC or AP Calculus AB) and (MATH 2B or AP Calculus BC) and (MATH 3A or MATH H3A). AP Calculus BC with a minimum score of 3. AP Calculus AB with a minimum score of 4. AP Calculus BC with a minimum score of 4

Overlaps with MATH 131A, STATS 120A.

MATH 130B. Probability and Stochastic Processes. 4 Units.
Exponential distributions, Poisson processes, continuous time Markov chains, renewal theory, insurance ruin and claim problems, numerical simulations in Matlab.

Prerequisite: MATH 130A or MATH 131A or STATS 120A

MATH 130C. Probability and Stochastic Processes. 4 Units.
Martingales, Invariance Principle, Brownian motions and applications in option pricing, stationary processes and applications in Wiener filter, numerical simulations in Matlab.

Prerequisite: MATH 130B

MATH 133A. Statistical Methods with Applications to Finance. 4 Units.
Overview of probability, statistics, and financial concepts: distribution, point estimation, confidence interval, linear regression, hypothesis testing, principal component analysis, financial applications.

Prerequisite: MATH 130A or MATH 131A or STATS 120A

MATH 133B. Statistical Methods with Applications to Finance. 4 Units.
Overview of markets and options: asset modeling, Brownian motion, risk neutrality, option pricing, value at risk, MC simulations.

Prerequisite: MATH 133A

MATH 133C. Statistical Methods with Applications to Finance. 4 Units.
Overview of interest theory, time value of money, annuities/cash flows with payments that are not contingent, loans, sinking funds, bonds, general cash flow and portfolios, immunization, duration and convexity, swaps.

Prerequisite: MATH 133B

MATH 140A. Elementary Analysis. 4 Units.
Introduction to real analysis, including convergence of sequence, infinite series, differentiation and integration, and sequences of functions. Students are expected to do proofs.

Prerequisite: (MATH 2B or AP Calculus BC) and (MATH 2D or MATH H2D) and (MATH 3A or MATH H3A) and MATH 13. AP Calculus BC with a minimum score of 4. MATH 13 with a grade of C or better

Restriction: Mathematics Majors have first consideration for enrollment.

MATH 140B. Elementary Analysis. 4 Units.
Introduction to real analysis including convergence of sequences, infinite series, differentiation and integration, and sequences of functions. Students are expected to do proofs.

Prerequisite: MATH 140A. MATH 140A with a grade of C- or better

Restriction: Mathematics Majors have first consideration for enrollment.

MATH 140C. Analysis in Several Variables . 4 Units.
Rigorous treatment of multivariable differential calculus. Jacobians, Inverse and Implicit Function theorems.

Prerequisite: MATH 140B

MATH H140A. Honors Introduction to Graduate Analysis I. 5 Units.
Construction of the real number system, topology of the real line, concepts of continuity, differential and integral calculus, sequences and series of functions, equicontinuity, metric spaces, multivariable differential and integral calculus, implicit functions, curves and surfaces.

Prerequisite: (MATH 2E or MATH H2E) and (MATH 3A or MATH H3A) and MATH 13 and MATH 121A and MATH 140A and MATH 140B. MATH 2E with a grade of A or better. MATH H2E with a grade of A or better. MATH 13 with a grade of A or better. MATH 140A with a grade of A or better. MATH 140B with a grade of A or better

Restriction: Mathematics Honors students only.

Concurrent with MATH 205A.

MATH H140B. Honors Introduction to Graduate Analysis II. 5 Units.
Construction of the real number system, topology of the real line, concepts of continuity, differential and integral calculus, sequences and series of functions, equicontinuity, metric spaces, multivariable differential and integral calculus, implicit functions, curves and surfaces.

Prerequisite: MATH H140A

Restriction: Mathematics Honors students only.

Concurrent with MATH 205B.

MATH H140C. Honors Introduction to Graduate Analysis III. 5 Units.
Construction of the real number system; topology of the real line; concepts of continuity, differential, and integral calculus; sequences and series of functions, equicontinuity, metric spaces, multivariable differential, and integral calculus; implicit functions, curves and surfaces.

Prerequisite: MATH H140B

Restriction: Mathematics Honors students only.

Concurrent with MATH 205C.

MATH 141. Introduction to Topology. 4 Units.
The elements of naive set theory and the basic properties of metric spaces. Introduction to topological properties.

Prerequisite: MATH 140A

MATH 147. Complex Analysis. 4 Units.
Rigorous treatment of basic complex analysis: analytic functions, Cauchy integral theory and its consequences, power series, residue calculus, harmonic functions, conformal mapping. Students are expected to do proofs.

Prerequisite or corequisite: MATH 140A and MATH 140B

Restriction: MATH 114A may not be taken for credit after MATH 147.

MATH 150. Introduction to Mathematical Logic. 4 Units.
First order logic through the Completeness Theorem for predicate logic.

Prerequisite: MATH 13 or (I&C SCI 6B and I&C SCI 6D). MATH 13 with a grade of C- or better

Overlaps with LPS 105B, PHILOS 105B.

MATH 161. Modern Geometry. 4 Units.
Euclidean Geometry; Hilbert's Axioms; Absolute Geometry; Hyperbolic Geometry; the Poincare Models; and Geometric Transformations.

Prerequisite: MATH 13 or (I&C SCI 6B and I&C SCI 6D). MATH 13 with a grade of C- or better

Restriction: Mathematics Majors have first consideration for enrollment.

MATH 162A. Introduction to Differential Geometry. 4 Units.
Applications of advanced calculus and linear algebra to the geometry of curves and surfaces in space.

Prerequisite: (MATH 2E or MATH H2E) and (MATH 3A or MATH H3A) and MATH 3D

MATH 162B. Introduction to Differential Geometry. 4 Units.
Applications of advanced calculus and linear algebra to the geometry of curves and surfaces in space.

Prerequisite: MATH 162A

MATH 173A. Introduction to Cryptology. 4 Units.
Introduction to some of the mathematics used in the making and breaking of codes, with applications to classical ciphers and public key systems. Includes topics from number theory, probability, and abstract algebra.

Prerequisite: (MATH 2B or AP Calculus BC) and (MATH 3A or MATH H3A) and MATH 13 or (I&C SCI 6B and I&C SCI 6D). AP Calculus BC with a minimum score of 4. MATH 13 with a grade of C or better

MATH 173B. Introduction to Cryptology. 4 Units.
Introduction to some of the mathematics used in the making and breaking of codes, with applications to classical ciphers and public key systems. The mathematics which is covered includes topics from number theory, probability, and abstract algebra.

Prerequisite: MATH 173A

MATH 175. Combinatorics . 4 Units.
Introduction to combinatorics including basic counting principles, permutations, combinations, binomial coefficients, inclusion-exclusion, derangements, ordinary and exponential generating functions, recurrence relations, Catalan numbers, Stirling numbers, and partition numbers.

Prerequisite: (MATH 2B or AP Calculus BC) and MATH 13. AP Calculus BC with a minimum score of 4. MATH 13 with a grade of C or better

MATH 176. Mathematics of Finance. 4 Units.
After reviewing tools from probability, statistics, and elementary differential and partial differential equations, concepts such as hedging, arbitrage, Puts, Calls, the design of portfolios, the derivation and solution of the Blac-Scholes, and other equations are discussed.

Prerequisite: MATH 3A or MATH H3A

Same as ECON 135.

Restriction: Business Economics Majors have first consideration for enrollment. Economics Majors have first consideration for enrollment. Quantitative Economics Majors have first consideration for enrollment. Mathematics Majors have first consideration for enrollment.

MATH 180A. Number Theory. 4 Units.
Introduction to number theory and applications. Divisibility, prime numbers, factorization. Arithmetic functions. Congruences. Quadratic residue. Diophantine equations. Introduction to cryptography.

Prerequisite: (MATH 3A or MATH H3A) and MATH 13. MATH 13 with a grade of C or better

Restriction: Mathematics Majors have first consideration for enrollment.

MATH 180B. Number Theory. 4 Units.
Introduction to number theory and applications. Analytic number theory, character sums, finite fields, discrete logarithm, computational complexity. Introduction to coding theory. Other topics as time permits.

Prerequisite: MATH 180A

Restriction: Mathematics Majors have first consideration for enrollment.

MATH 184. History of Mathematics. 4 Units.
Topics vary from year to year. Some possible topics: mathematics in ancient times; the development of modern analysis; the evolution of geometric ideas. Students will be assigned individual topics for term papers.

Corequisite: MATH 184L
Prerequisite: MATH 120A and MATH 140A

Restriction: Mathematics Majors have first consideration for enrollment.

MATH 184L. History of Mathematics Lesson Lab. 1 Unit.
Aspiring math teachers research, design, present, and peer review middle school or high school math lessons that draw from history of mathematics topics.

Corequisite: MATH 184
Prerequisite: PHY SCI 5

MATH 189. Special Topics in Mathematics. 4 Units.
Offered from time to time, but not on a regular basis. Content and prerequisites vary with the instructor.

Prerequisite: Prerequisites vary.

Repeatability: Unlimited as topics vary.

MATH 192. Studies in the Learning and Teaching of Secondary Mathematics. 2 Units.
Focus is on historic and current mathematical concepts related to student learning and effective math pedagogy, with fieldwork in grades 6-14.

Grading Option: Pass/no pass only.

Repeatability: May be taken for credit 2 times.

MATH 194. Problem Solving Seminar. 2 Units.
Develops ability in analytical thinking and problem solving, using problems of the type found in the Mathematics Olympiad and the Putnam Mathematical Competition. Students taking the course in fall will prepare for and take the Putnam examination in December.

Grading Option: Pass/no pass only.

Repeatability: May be taken for credit 2 times.

MATH 199A. Special Studies in Mathematics. 2-4 Units.
Supervised reading. For outstanding undergraduate Mathematics majors in supervised but independent reading or research of mathematical topics.

Repeatability: Unlimited as topics vary.

MATH 199B. Special Studies in Mathematics. 2-4 Units.
Supervised reading. For outstanding undergraduate Mathematics majors in supervised but independent reading or research of mathematical topics.

Repeatability: Unlimited as topics vary.

MATH 199C. Special Studies in Mathematics. 2-4 Units.
Supervised reading. For outstanding undergraduate Mathematics majors in supervised but independent reading or research of mathematical topics.

Repeatability: Unlimited as topics vary.

MATH 205A. Introduction to Graduate Analysis. 5 Units.
Construction of the real number system, topology of the real line, concepts of continuity, differential and integral calculus, sequences and series of functions, equicontinuity, metric spaces, multivariable differential and integral calculus, implicit functions, curves and surfaces.

Prerequisite: (MATH 2E or MATH H2E) and (MATH 3A MATH H3A) and MATH 13. MATH 2E with a grade of A or better. MATH H2E with a grade of A or better. MATH 13 with a grade of C or better

Concurrent with MATH H140A.

MATH 205B. Introduction to Graduate Analysis. 5 Units.
Construction of the real number system, topology of the real line, concepts of continuity, differential and integral calculus, sequences and series of functions, equicontinuity, metric spaces, multivariable differential and integral calculus, implicit functions, curves and surfaces.

Prerequisite: MATH 205A

Concurrent with MATH H140B.

MATH 205C. Introduction to Graduate Analysis. 5 Units.
Construction of the real number system, topology of the real line, concepts of continuity, differential and integral calculus, sequences and series of functions, equicontinuity, metric spaces, multivariable differential and integral calculus, implicit functions, curves and surfaces.

Prerequisite: MATH 205B

Concurrent with MATH H140C.

MATH 206A. Introduction to Graduate Algebra. 5 Units.
Introduction to abstract linear algebra, including bases, linear transformation, eigenvectors, canonical forms, inner products, symmetric operators. Introduction to groups, rings, and fields including examples of groups, group actions, Sylow theorems, modules over principal ideal domains, polynomials, and Galois groups.

Prerequisite: MATH 3A or MATH H3A

Concurrent with MATH H120A.

MATH 206B. Introduction to Graduate Algebra. 5 Units.
Introduction to abstract linear algebra, including bases, linear transformation, eigenvectors, canonical forms, inner products, symmetric operators. Introduction to groups, rings, and fields including examples of groups, group actions, Sylow theorems, modules over principal ideal domains, polynomials, and Galois groups.

Prerequisite: MATH 206A

Concurrent with MATH H120B.

MATH 206C. Introduction to Graduate Algebra. 5 Units.
Introduction to abstract linear algebra, including bases, linear transformation, eigenvectors, canonical forms, inner products, symmetric operators. Introduction to groups, rings, and fields including examples of groups, group actions, Sylow theorems, modules over principal ideal domains, polynomials, and Galois groups.

Prerequisite: MATH 206B

Concurrent with MATH H120C.

MATH 210A. Real Analysis. 4 Units.
Measure theory, Lebesgue integral, signed measures, Radon-Nikodym theorem, functions of bounded variation and absolutely continuous functions, classical Banach spaces, Lp spaces, integration on locally compact spaces and the Riesz-Markov theorem, measure and outer measure, product measure spaces.

Prerequisite: MATH 140C

MATH 210B. Real Analysis. 4 Units.
Measure theory, Lebesgue integral, signed measures, Radon-Nikodym theorem, functions of bounded variation and absolutely continuous functions, classical Banach spaces, Lp spaces, integration on locally compact spaces and the Riesz-Markov theorem, measure and outer measure, product measure spaces.

Prerequisite: MATH 210A

MATH 210C. Real Analysis. 4 Units.
Measure theory, Lebesgue integral, signed measures, Radon-Nikodym theorem, functions of bounded variation and absolutely continuous functions, classical Banach spaces, Lp spaces, integration on locally compact spaces and the Riesz-Markov theorem, measure and outer measure, product measure spaces.

Prerequisite: MATH 210B

MATH 211C. Topics in Analysis . 4 Units.
Studies in selected areas of Real Analysis, a continuation of MATH 210A-MATH 210B-MATH 210C. Topics addressed vary each quarter.

Prerequisite: MATH 211B

MATH 218A. Introduction to Manifolds and Geometry. 4 Units.
General topology and fundamental groups, covering space; Stokes theorem on manifolds, selected topics on abstract manifold theory.

Prerequisite: MATH 205C

MATH 218B. Introduction to Manifolds and Geometry. 4 Units.
General topology and fundamental groups, covering space; Stokes theorem on manifolds, selected topics on abstract manifold theory.

Prerequisite: MATH 218A

MATH 218C. Introduction to Manifolds and Geometry. 4 Units.
General topology and fundamental groups, covering space; Stokes theorem on manifolds, selected topics on abstract manifold theory.

Prerequisite: MATH 218B

MATH 220A. Analytic Function Theory. 4 Units.
Standard theorems about analytic functions. Harmonic functions. Normal families. Conformal mapping.

Prerequisite: MATH 140C

MATH 220B. Analytic Function Theory. 4 Units.
Standard theorems about analytic functions. Harmonic functions. Normal families. Conformal mapping.

Prerequisite: MATH 220A

MATH 220C. Analytic Function Theory. 4 Units.
Standard theorems about analytic functions. Harmonic functions. Normal families. Conformal mapping.

Prerequisite: MATH 220B

MATH 222A. Several Complex Variables and Complex Geometry. 4 Units.
Several Complex variables, d-bar problems, mappings, Kaehler geometry, de Rham and Dolbeault Theorems, Chern Classes, Hodge Theorems, Calabi conjecture, Kahler-Einstein geometry, Monge-Ampere.

Prerequisite: MATH 218C and MATH 220C

MATH 225A. Introduction to Numerical Analysis and Scientific Computing. 4 Units.
Introduction to fundamentals of numerical analysis from an advanced viewpoint. Error analysis, approximation of functions, nonlinear equations.

Prerequisite: MATH 3D and (MATH 105A and MATH 105B) or (MATH 140A and MATH 140B) and MATH 121A and (MATH 112A or ENGRMAE 140)

Restriction: Graduate students only.

MATH 225B. Introduction to Numerical Analysis and Scientific Computing. 4 Units.
Introduction to fundamentals of numerical analysis from an advanced viewpoint. Numerical linear algebra, numerical solutions of differential equations; stability.

Prerequisite: MATH 225A

Restriction: Graduate students only.

MATH 225C. Introduction to Numerical Analysis and Scientific Computing. 4 Units.
Introduction to fundamentals of numerical analysis from an advanced viewpoint. Numerical linear algebra, numerical solutions of differential equations; stability.

Prerequisite: MATH 225B

Restriction: Graduate students only.

MATH 226A. Computational Differential Equations. 4 Units.
Finite difference and finite element methods. Quick treatment of functional and nonlinear analysis background: weak solution, Lp spaces, Sobolev spaces. Approximation theory. Fourier and Petrov-Galerkin methods; mesh generation. Elliptic, parabolic, hyperbolic cases in 226A-B-C, respectively.

Prerequisite: MATH 3D and (MATH 112A or ENGRMAE 140) and (MATH 140B or MATH 105B)

MATH 226B. Computational Differential Equations. 4 Units.
Finite difference and finite element methods. Quick treatment of functional and nonlinear analysis background: weak solution, Lp spaces, Sobolev spaces. Approximation theory. Fourier and Petrov-Galerkin methods; mesh generation. Elliptic, parabolic, hyperbolic cases in 226A-B-C, respectively.

Prerequisite: MATH 226A

MATH 226C. Computational Differential Equations. 4 Units.
Finite difference and finite element methods. Quick treatment of functional and nonlinear analysis background: weak solution, Lp spaces, Sobolev spaces. Approximation theory. Fourier and Petrov-Galerkin methods; mesh generation. Elliptic, parabolic, hyperbolic cases in 226A-B-C, respectively.

Prerequisite: MATH 226B

MATH 227A. Mathematical and Computational Biology. 4 Units.
Analytical and numerical methods for dynamical systems, temporal-spatial dynamics, steady state, stability, stochasticity. Application to life sciences: genetics, tissue growth and patterning, cancers, ion channels gating, signaling networks, morphogen gradients. Analytical methods.

Prerequisite: (MATH 2A or AP Calculus BC or AP Calculus AB) and (MATH 2B or AP Calculus BC or MATH 5B) and (MATH 3A or MATH H3A). AP Calculus BC with a minimum score of 3. AP Calculus AB with a minimum score of 4. AP Calculus BC with a minimum score of 4

MATH 227B. Mathematical and Computational Biology. 4 Units.
Analytical and numerical methods for dynamical systems, temporal-spatial dynamics, steady state, stability, stochasticity. Application to life sciences: genetics, tissue growth and patterning, cancers, ion channels gating, signaling networks, morphogen gradients. Numerical simulations.

Prerequisite: MATH 227A

MATH 227C. Mathematical and Computational Biology . 4 Units.
Analytical and numerical methods for dynamical systems, temporal-spatial dynamics, steady state, stability, stochasticity. Application to life sciences: genetics, tissue growth and patterning, cancers, ion channels gating, signaling networks, morphogen gradients. Probabilistic methods.

Prerequisite: MATH 227A

Same as COMPSCI 285.

MATH 230A. Algebra. 4 Units.
Elements of the theories of groups, rings, fields, modules. Galois theory. Modules over principal ideal domains. Artinian, Noetherian, and semisimple rings and modules.

Prerequisite: MATH 120A and MATH 121A and MATH 121B

MATH 230B. Algebra. 4 Units.
Elements of the theories of groups, rings, fields, modules. Galois theory. Modules over principal ideal domains. Artinian, Noetherian, and semisimple rings and modules.

Prerequisite: MATH 230A

MATH 230C. Algebra. 4 Units.
Elements of the theories of groups, rings, fields, modules. Galois theory. Modules over principal ideal domains. Artinian, Noetherian, and semisimple rings and modules.

Prerequisite: MATH 230B

MATH 232A. Algebraic Number Theory. 4 Units.
Algebraic integers, prime ideals, class groups, Dirichlet unit theorem, localization, completion, Cebotarev density theorem, L-functions, Gauss sums, diophantine equations, zeta functions over finite fields. Introduction to class field theory.

Prerequisite: MATH 230C

MATH 232B. Algebraic Number Theory. 4 Units.
Algebraic integers, prime ideals, class groups, Dirichlet unit theorem, localization, completion, Cebotarev density theorem, L-functions, Gauss sums, diophantine equations, zeta functions over finite fields. Introduction to class field theory.

Prerequisite: MATH 232A

MATH 232C. Algebraic Number Theory. 4 Units.
Algebraic integers, prime ideals, class groups, Dirichlet unit theorem, localization, completion, Cebotarev density theorem, L-functions, Gauss sums, diophantine equations, zeta functions over finite fields. Introduction to class field theory.

Prerequisite: MATH 232B

MATH 233A. Algebraic Geometry. 4 Units.
Basic commutative algebra and classical algebraic geometry. Algebraic varieties, morphisms, rational maps, blow ups. Theory of schemes, sheaves, divisors, cohomology. Algebraic curves and surfaces, Riemann-Roch theorem, Jacobians, classification of curves and surfaces.

Prerequisite: MATH 230C

MATH 233B. Algebraic Geometry. 4 Units.
Basic commutative algebra and classical algebraic geometry. Algebraic varieties, morphisms, rational maps, blow ups. Theory of schemes, sheaves, divisors, cohomology. Algebraic curves and surfaces, Riemann-Roch theorem, Jacobians, classification of curves and surfaces.

Prerequisite: MATH 233A

MATH 233C. Algebraic Geometry. 4 Units.
Basic commutative algebra and classical algebraic geometry. Algebraic varieties, morphisms, rational maps, blow ups. Theory of schemes, sheaves, divisors, cohomology. Algebraic curves and surfaces, Riemann-Roch theorem, Jacobians, classification of curves and surfaces.

Prerequisite: MATH 233B

MATH 235A. Mathematics of Cryptography. 4 Units.
Mathematics of public key cryptography: encryption and signature schemes; RSA; factoring; primality testing; discrete log based cryptosystems, elliptic and hyperelliptic curve cryptography and additional topics as determined by the instructor.

Prerequisite: MATH 230C

MATH 240A. Differential Geometry. 4 Units.
Riemannian manifolds, connections, curvature and torsion. Submanifolds, mean curvature, Gauss curvature equation. Geodesics, minimal submanifolds, first and second fundamental forms, variational formulas. Comparison theorems and their geometric applications. Hodge theory applications to geometry and topology.

MATH 240B. Differential Geometry. 4 Units.
Riemannian manifolds, connections, curvature and torsion. Submanifolds, mean curvature, Gauss curvature equation. Geodesics, minimal submanifolds, first and second fundamental forms, variational formulas. Comparison theorems and their geometric applications. Hodge theory applications to geometry and topology.

Prerequisite: MATH 240A

MATH 240C. Differential Geometry. 4 Units.
Riemannian manifolds, connections, curvature and torsion. Submanifolds, mean curvature, Gauss curvature equation. Geodesics, minimal submanifolds, first and second fundamental forms, variational formulas. Comparison theorems and their geometric applications. Hodge theory applications to geometry and topology.

Prerequisite: MATH 240B

MATH 245A. Topics in Differential Geometry. 4 Units.
Studies in selected areas of differential geometry, a continuation of MATH 240A-MATH 240B-MATH 240C. Topics addressed vary each quarter.

Prerequisite: MATH 240C

Repeatability: Unlimited as topics vary.

MATH 245B. Topics in Differential Geometry. 4 Units.
Studies in selected areas of differential geometry, a continuation of MATH 240A-MATH 240B-MATH 240C. Topics addressed vary each quarter.

Prerequisite: MATH 245A

Repeatability: Unlimited as topics vary.

MATH 245C. Topics in Differential Geometry. 4 Units.
Studies in selected areas of differential geometry, a continuation of MATH 240A-MATH 240B-MATH 240C. Topics addressed vary each quarter.

Prerequisite: MATH 245B

Repeatability: Unlimited as topics vary.

MATH 250A. Algebraic Topology. 4 Units.
Provides fundamental materials in algebraic topology: fundamental group and covering space, homology and cohomology theory, and homotopy group.

Prerequisite: MATH 230A

MATH 250B. Algebraic Topology. 4 Units.
Provides fundamental materials in algebraic topology: fundamental group and covering space, homology and cohomology theory, and homotopy group.

Prerequisite: MATH 250A

MATH 250C. Algebraic Topology. 4 Units.
Provides fundamental materials in algebraic topology: fundamental group and covering space, homology and cohomology theory, and homotopy group.

Prerequisite: MATH 250B

MATH 260A. Functional Analysis. 4 Units.
Normed linear spaces, Hilbert spaces, Banach spaces, Stone-Weierstrass Theorem, locally convex spaces, bounded operators on Banach and Hilbert spaces, the Gelfand-Neumark Theorem for commutative C*-algebras, the spectral theorem for bounded self-adjoint operators, unbounded operators on Hilbert spaces.

Prerequisite: MATH 210C and MATH 220C

MATH 260B. Functional Analysis. 4 Units.
Normed linear spaces, Hilbert spaces, Banach spaces, Stone-Weierstrass Theorem, locally convex spaces, bounded operators on Banach and Hilbert spaces, the Gelfand-Neumark Theorem for commutative C*-algebras, the spectral theorem for bounded self-adjoint operators, unbounded operators on Hilbert spaces.

Prerequisite: MATH 260A

MATH 260C. Functional Analysis. 4 Units.
Normed linear spaces, Hilbert spaces, Banach spaces, Stone-Weierstrass Theorem, locally convex spaces, bounded operators on Banach and Hilbert spaces, the Gelfand-Neumark Theorem for commutative C*-algebras, the spectral theorem for bounded self-adjoint operators, unbounded operators on Hilbert spaces.

Prerequisite: MATH 260B

MATH 270A. Probability. 4 Units.
Probability spaces, distribution and characteristic functions. Strong limit theorems. Limit distributions for sums of independent random variables. Conditional expectation and martingale theory. Stochastic processes.

Prerequisite: MATH 130C and MATH 210C

MATH 270B. Probability. 4 Units.
Probability spaces, distribution and characteristic functions. Strong limit theorems. Limit distributions for sums of independent random variables. Conditional expectation and martingale theory. Stochastic processes.

Prerequisite: MATH 270A

MATH 270C. Probability. 4 Units.
Probability spaces, distribution and characteristic functions. Strong limit theorems. Limit distributions for sums of independent random variables. Conditional expectation and martingale theory. Stochastic processes.

Prerequisite: MATH 270B

MATH 271A. Stochastic Processes. 4 Units.
Processes with independent increments, Wiener and Gaussian processes, function space integrals, stationary processes, Markov processes.

Prerequisite: MATH 210C

Overlaps with STATS 270.

MATH 271B. Stochastic Processes. 4 Units.
Processes with independent increments, Wiener and Gaussian processes, function space integrals, stationary processes, Markov processes.

Prerequisite: MATH 271A

Overlaps with STATS 270.

MATH 271C. Stochastic Processes. 4 Units.
Processes with independent increments, Wiener and Gaussian processes, function space integrals, stationary processes, Markov processes.

Prerequisite: MATH 271B

Overlaps with STATS 270.

MATH 274. Topics in Probability. 4 Units.
Selected topics, such as theory of stochastic processes, martingale theory, stochastic integrals, stochastic differential equations.

Prerequisite: MATH 270C

Repeatability: Unlimited as topics vary.

MATH 277A. Topics in Mathematical Physics . 4 Units.
Studies in selected areas of mathematical physics. Topics addressed vary each quarter.

Repeatability: May be repeated for credit unlimited times.

MATH 277B. Topics in Mathematical Physics . 4 Units.
Studies in selected areas of mathematical physics. Topics addressed vary each quarter.

Prerequisite: MATH 277A

Repeatability: May be repeated for credit unlimited times.

MATH 277C. Topics in Mathematical Physics . 4 Units.
Studies in selected areas of mathematical physics. Topics addressed vary each quarter.

Prerequisite: MATH 277B

Repeatability: May be repeated for credit unlimited times.

MATH 280A. Mathematical Logic. 4 Units.
Basic set theory; models, compactness, and completeness; basic model theory; Incompleteness and Gödel's Theorems; basic recursion theory; constructible sets.

MATH 280B. Mathematical Logic. 4 Units.
Basic set theory; models, compactness, and completeness; basic model theory; Incompleteness and Gödel's Theorems; basic recursion theory; constructible sets.

Prerequisite: MATH 280A

MATH 280C. Mathematical Logic. 4 Units.
Basic set theory; models, compactness, and completeness; basic model theory; Incompleteness and Gödel's Theorems; basic recursion theory; constructible sets.

Prerequisite: MATH 280B

MATH 281A. Set Theory. 4 Units.
Ordinals, cardinals, cardinal arithmetic, combinatorial set theory, models of set theory, Gödel's constructible universe, forcing, large cardinals, iterate forcing, inner model theory, fine structure.

Prerequisite: MATH 280C

MATH 281B. Set Theory. 4 Units.
Ordinals, cardinals, cardinal arithmetic, combinatorial set theory, models of set theory, Gödel's constructible universe, forcing, large cardinals, iterate forcing, inner model theory, fine structure.

Prerequisite: MATH 281A

MATH 281C. Set Theory. 4 Units.
Ordinals, cardinals, cardinal arithmetic, combinatorial set theory, models of set theory, Gödel's constructible universe, forcing, large cardinals, iterate forcing, inner model theory, fine structure.

Prerequisite: MATH 281B

MATH 282A. Model Theory. 4 Units.
Languages, structures, compactness and completeness. Model-theoretic constructions. Omitting types theorems. Morley's theorem. Ranks, forking. Model completeness. O-minimality. Applications to algebra.

Prerequisite: MATH 280C

MATH 282B. Model Theory. 4 Units.
Languages, structures, compactness and completeness. Model-theoretic constructions. Omitting types theorems. Morley's theorem. Ranks, forking. Model completeness. O-minimality. Applications to algebra.

Prerequisite: MATH 282A

MATH 282C. Model Theory. 4 Units.
Languages, structures, compactness and completeness. Model-theoretic constructions. Omitting types theorems. Morley's theorem. Ranks, forking. Model completeness. O-minimality. Applications to algebra.

Prerequisite: MATH 282B

MATH 285A. Topics in Mathematical Logic. 4 Units.
Studies in selected areas of mathematical logic, a continuation of MATH 280A-MATH 280B-MATH 280C. Topics addressed vary each quarter.

Prerequisite: MATH 280C

Repeatability: Unlimited as topics vary.

MATH 285B. Topics in Mathematical Logic. 4 Units.
Studies in selected areas of mathematical logic, a continuation of MATH 280A-MATH 280B-MATH 280C. Topics addressed vary each quarter.

Prerequisite: MATH 285A

Repeatability: Unlimited as topics vary.

MATH 285C. Topics in Mathematical Logic. 4 Units.
Studies in selected areas of mathematical logic, a continuation of MATH 280A-MATH 280B-MATH 280C. Topics addressed vary each quarter.

Prerequisite: MATH 285B

Repeatability: Unlimited as topics vary.

MATH 290A. Methods in Applied Mathematics. 4 Units.
Introduction to ODEs and dynamical systems: existence and uniqueness. Equilibria and periodic solutions. Bifurcation theory. Perturbation methods: approximate solution of differential equations. Multiple scales and WKB. Matched asymptotic. Calculus of variations: direct methods, Euler-Lagrange equation. Second variation and Legendre condition.

MATH 290B. Methods in Applied Mathematics. 4 Units.
Introduction to ODEs and dynamical systems: existence and uniqueness. Equilibria and periodic solutions. Bifurcation theory. Perturbation methods: approximate solution of differential equations. Multiple scales and WKB. Matched asymptotic. Calculus of variations: direct methods, Euler-Lagrange equation. Second variation and Legendre condition.

Prerequisite: MATH 290A

MATH 290C. Methods in Applied Mathematics. 4 Units.
Introduction to ODEs and dynamical systems: existence and uniqueness. Equilibria and periodic solutions. Bifurcation theory. Perturbation methods: approximate solution of differential equations. Multiple scales and WKB. Matched asymptotic. Calculus of variations: direct methods, Euler-Lagrange equation. Second variation and Legendre condition.

Prerequisite: MATH 290B

MATH 295A. Partial Differential Equations. 4 Units.
Theory and techniques for linear and nonlinear partial differential equations. Local and global theory of partial differential equations: analytic, geometric, and functional analytic methods.

Prerequisite: MATH 210C and MATH 112B and MATH 112C

MATH 295B. Partial Differential Equations. 4 Units.
Theory and techniques for linear and nonlinear partial differential equations. Local and global theory of partial differential equations: analytic, geometric, and functional analytic methods.

Prerequisite: MATH 295A

MATH 295C. Partial Differential Equations. 4 Units.
Theory and techniques for linear and nonlinear partial differential equations. Local and global theory of partial differential equations: analytic, geometric, and functional analytic methods.

Prerequisite: MATH 295B

MATH 296. Topics in Partial Differential Equations. 4 Units.
Studies in selected areas of partial differential equations, a continuation of MATH 295A-MATH 295B-MATH 295C. Topics addressed vary each quarter.

Prerequisite: MATH 295C

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

MATH 297. Mathematics Colloquium. 1 Unit.
Weekly colloquia on topics of current interest in mathematics.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

MATH 298A. Seminar . 2 Units.
Seminars organized for detailed discussion of research problems of current interest in the Department. The format, content, frequency, and course value are variable.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: Unlimited as topics vary.

MATH 298B. Seminar . 2 Units.
Seminars organized for detailed discussion of research problems of current interest in the Department. The format, content, frequency, and course value are variable.

Prerequisite: MATH 298A

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: Unlimited as topics vary.

MATH 298C. Seminar . 2 Units.
Seminars organized for detailed discussion of research problems of current interest in the Department. The format, content, frequency, and course value are variable.

Prerequisite: MATH 298B

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: Unlimited as topics vary.

MATH 299A. Supervised Reading and Research. 1-12 Units.
Supervised reading and research with Mathematics faculty.

Repeatability: May be repeated for credit unlimited times.

MATH 299B. Supervised Reading and Research. 1-12 Units.
Supervised reading and research with Mathematics faculty.

Prerequisite: MATH 299A

Repeatability: May be repeated for credit unlimited times.

MATH 299C. Supervised Reading and Research. 1-12 Units.
Supervised reading and research with Mathematics faculty.

Prerequisite: MATH 299B

Repeatability: May be repeated for credit unlimited times.

MATH 399. University Teaching. 1-4 Units.
Limited to Teaching Assistants.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.