

# Mathematics

---

Department Website: <http://math.uchicago.edu>

## Program of Study

The Department of Mathematics provides an environment of research and comprehensive instruction in mathematics and applied mathematics at both undergraduate and graduate levels. Both a BA and a BS program in mathematics are offered, including a BS degree in applied mathematics and a BS degree in mathematics with a specialization in economics. Students in other fields of study may also complete a minor in mathematics; information follows the description of the major.

The requirements for a degree in mathematics or in applied mathematics express the educational intent of the Department of Mathematics; they are drawn with an eye toward the cumulative character of an education based in mathematics, the present emerging state of mathematics, and the scholarly and professional prerequisites of an academic career in mathematics.

Requirements for each bachelor's degree look to the advancement of students' general education in modern mathematics and their knowledge of its relation with the other sciences (BS) or with the other arts (BA).

Descriptions of the detailed requirements that give meaning to these educational intentions follow. Students should understand that any particular degree requirement can be modified if persuasive reasons are presented to the department; petitions to modify requirements are submitted in person to the director of undergraduate studies or to one of the departmental counselors. Students should note that only one undergraduate degree may be earned from the Department of Mathematics.

## Placement

At what level does an entering student begin mathematics at the University of Chicago? Every entering student must take the Mathematics Placement Test. This online test must be taken during the summer before arrival on campus. Scores on the Mathematics Placement Test, combined with a student's high school record, determine the appropriate beginning mathematics course for each student: MATH 11200 Studies in Mathematics I, MATH 13100 Elementary Functions and Calculus I, or MATH 15100 Calculus I. Students who wish to begin at a level higher than MATH 15100 Calculus I must take the Calculus Accreditation Examination, unless they have sufficiently good Advanced Placement scores as described in the following paragraphs. Students who place into MATH 13100 Elementary Functions and Calculus I on the basis of the Mathematics Placement Test and who wish to improve their placement must take the Calculus Accreditation Exam.

Additionally, the College administers the Calculus Accreditation Examination. This exam must be taken during the summer before arrival on campus. On the basis of this exam, a

student may receive placement out of up to three quarters of calculus. Students earning one quarter of placement on this exam may begin MATH 15200 Calculus II, students earning two quarters of placement may begin with MATH 15300 Calculus III, and students earning three quarters of placement may begin with MATH 15910 Introduction to Proofs in Analysis, MATH 19520 Mathematical Methods for Social Sciences, MATH 19620 Linear Algebra, or MATH 20000 Mathematical Methods for Physical Sciences I. Strong students, especially those planning to continue with higher level mathematics or other disciplines requiring advanced mathematics, are urged to take this accreditation exam. The Calculus Accreditation Examination may be taken only once and only by incoming students (first-years or transfers).

On the basis of the Calculus Accreditation Examination or with a score of 5 on the Calculus BC Advanced Placement exam, students may also be invited to begin MATH 16100-16200-16300 Honors Calculus I-II-III or MATH 16110-16210-16310 Honors Calculus I (IBL); Honors Calculus II (IBL); Honors Calculus III (IBL). These sequences build on the sound practical background provided in strong high school calculus courses and best prepare entering students for further study in mathematics. Students who take either version of Honors Calculus forgo placement out of MATH 15100 Calculus I and/or MATH 15200 Calculus II in order to take one of these full Honors Calculus sequences.

A small number of students each year receive placement recommendations beyond Honors Calculus. Admission to MATH 20700 Honors Analysis in Rn I is by invitation only to those first-year students with superior performance on the Calculus Accreditation Examination or to those sophomores who receive a strong recommendation from their instructor in MATH 16100-16200-16300 Honors Calculus I-II-III or MATH 16110-16210-16310 Honors Calculus I (IBL); Honors Calculus II (IBL); Honors Calculus III (IBL). Students who are granted three quarters of calculus placement on the basis of the Calculus Accreditation Examination and who do not qualify for admission to MATH 20700 Honors Analysis in Rn I will place into MATH 15910 Introduction to Proofs in Analysis. This latter option includes the possible starting points of MATH 19520 Mathematical Methods for Social Sciences, MATH 19620 Linear Algebra, or MATH 20000 Mathematical Methods for Physical Sciences I. Such students may also consult with one of the departmental counselors about the option of beginning with MATH 16100 Honors Calculus I/ MATH 16110 Honors Calculus I (IBL) so that they would be eligible for admission to Honors Analysis the following year.

Students who submit a score of 5 on the Calculus AB Advanced Placement exam in mathematics or a score of 4 or 5 on the Calculus BC Advanced Placement exam in mathematics receive placement out of MATH 15100 Calculus I. Currently no course credit or placement is offered in the Department of Mathematics at UChicago for work done in an International Baccalaureate Programme or for British A-level or O-level examinations, and students with these backgrounds are strongly encouraged to take the Calculus Accreditation Examination.

## Program Requirements

### Undergraduate Programs

Four bachelor's degrees are available in the Department of Mathematics: the BA in mathematics, the BS in mathematics, the BS in applied mathematics, and the BS in mathematics with specialization in economics. Programs qualifying students for the degree of BA provide more elective freedom. Programs qualifying students for the degrees of BS require more emphasis in the physical sciences, while the BS in mathematics with specialization in economics has its own set of specialized courses with more electives in economics in place of electives in the physical sciences. All degree programs, whether qualifying students for a degree in mathematics or in applied mathematics, require fulfillment of the College's general education requirements. The general education sequence in the physical sciences must be selected from either first-year chemistry or first-year physics.

Except for the BS in mathematics with specialization in economics, each degree requires at least five courses outside mathematics (detailed descriptions follow for each degree). These courses must be within the Physical Sciences Collegiate Division (PSCD) or from Computational Neuroscience (CPNS). One of these courses must complete the three-quarter sequence in basic chemistry or basic physics. At least two of these courses must be from a single department and all must be chosen from among Astronomy (20000 or above), Chemistry, Computer Science (not including 10100, 10200, 11000, 11100, or 11200), Physics (12000s or above), Geophysical Sciences, Statistics (22000 or above), CPNS, or Molecular Engineering. Graduate courses from these departments may also be used to fulfill these requirements. No courses from the Financial Mathematics program may be used in any of the undergraduate degree programs in mathematics. Please note in particular the different requirements outside of mathematics described below in the degree program for the BS in mathematics with specialization in economics.

### Degree Programs in Mathematics

Students who are majoring in mathematics are required to complete: a 10000-level sequence in calculus (or to demonstrate equivalent competence on the Calculus Accreditation Exam); either MATH 16300 Honors Calculus III or MATH 16310 Honors Calculus III (IBL) as the third quarter of the calculus sequence or MATH 15910 Introduction to Proofs in Analysis; the linear algebra course MATH 20250 Abstract Linear Algebra; a three-quarter sequence in analysis (MATH 20300-20400-20500 Analysis in  $R^n$  I-II-III or MATH 20310-20410-20510 Analysis in  $R^n$  I (accelerated); Analysis in  $R^n$  II (accelerated); Analysis in  $R^n$  III (accelerated) or MATH 20700-20800-20900 Honors Analysis in  $R^n$  I-II-III); and one quarter of an algebra sequence (MATH 25400-25500-25600 Basic Algebra I-II-III or MATH 25700-25800-25900 Honors Basic Algebra I-II-III). Students may not use both MATH 15910 Introduction to Proofs in Analysis and (MATH 16300 Honors Calculus III/MATH 16310 Honors Calculus III (IBL)) to meet major or minor requirements. For students whose first mathematics course at the University of Chicago is MATH 20700 Honors Analysis in  $R^n$  I, the MATH 15910 Introduction to Proofs in Analysis/MATH 16300 Honors Calculus III/MATH 16310 Honors Calculus III (IBL) requirement is waived. For students who complete MATH 20700 Honors Analysis in  $R^n$  I, the MATH 20250 Abstract

Linear Algebra requirement is waived, but the student must then take an additional course from the List of Approved Courses.

Candidates for the BA and BS in mathematics take at least one course in basic algebra. BA candidates may opt for the first quarter of either the regular or the honors sequence (MATH 25400-25500-25600 Basic Algebra I-II-III or MATH 25700-25800-25900 Honors Basic Algebra I-II-III), whereas candidates for the BS degree must take the first two quarters of one of the two sequences. MATH 25700-25800-25900 Honors Basic Algebra I-II-III is designated as an honors version of Basic Algebra. Registration for this course is the option of the individual student, but consultation with one of the departmental counselors is strongly advised.

The remaining mathematics courses needed in the programs (three for the BA, two for the BS) must be selected, with due regard for prerequisites, from the following list of approved mathematics courses. Note that STAT 25100 Introduction to Mathematical Probability or STAT 25150 Introduction to Mathematical Probability-A also meet the requirement. BA candidates may include MATH 25500 Basic Algebra II or MATH 25800 Honors Basic Algebra II. Mathematics courses in the Paris Mathematics (p. ) program each Spring Quarter may also be used to meet this requirement.

#### List of Approved Courses

MATH 17500	Basic Number Theory	100
MATH 17600	Basic Geometry	100
MATH 21100	Basic Numerical Analysis	100
MATH 21200	Advanced Numerical Analysis	100
MATH 23500	Markov Chains, Martingales, and Brownian Motion	100
MATH 24100	Topics in Geometry	100
MATH 24200	Algebraic Number Theory	100
MATH 24300	Introduction to Algebraic Curves	100
MATH 24400	Introduction to Algebraic Geometry	100
MATH 25600	Basic Algebra III	100
MATH 25900	Honors Basic Algebra III	100
MATH 26200	Point-Set Topology	100
MATH 26300	Introduction to Algebraic Topology	100
MATH 26700	Introduction to Representation Theory of Finite Groups	100
MATH 26800	Introduction to Commutative Algebra	100
MATH 27000	Basic Complex Variables	100
MATH 27100	Measure and Integration	100
MATH 27200	Basic Functional Analysis	100
MATH 27300	Basic Theory of Ordinary Differential Equations	100
MATH 27400	Introduction to Differentiable Manifolds and Integration on Manifolds	100

MATH 27500	Basic Theory of Partial Differential Equations	100
MATH 27700	Mathematical Logic I	100
MATH 27800	Mathematical Logic II	100
MATH 28000	Introduction to Formal Languages	100
MATH 28100	Introduction to Complexity Theory	100
MATH 28410	Honors Combinatorics	100
MATH 29200	Chaos, Complexity, and Computers	100
MATH 29700	Proseminar in Mathematics *	100
MATH 30200	Computability Theory I	100
MATH 30300	Computability Theory II	100
MATH 30900	Model Theory I	100
MATH 31000	Model Theory II	100
MATH 31200	Analysis I	100
MATH 31300	Analysis II	100
MATH 31400	Analysis III	100
MATH 31700	Topology and Geometry I	100
MATH 31800	Topology and Geometry II	100
MATH 31900	Topology and Geometry III	100
MATH 32500	Algebra I	100
MATH 32600	Algebra II	100
MATH 32700	Algebra III	100
STAT 25100	Introduction to Mathematical Probability	100
STAT 25150	Introduction to Mathematical Probability-A	100

\* as approved

BS candidates are further required to select a minor field, which consists of three additional courses that are outside the Department of Mathematics and either are within the same department in the Physical Sciences Collegiate Division (PSCD) or are among Computational Neuroscience (CPNS) courses. These courses must be chosen in consultation with one of the departmental counselors.

## Summaries of Requirements

### Summary of Requirements: Mathematics BA

#### GENERAL EDUCATION

One of the following sequences:	200
CHEM 10100    Introductory General Chemistry I & CHEM 10200    and Introductory General Chemistry II	
CHEM 11100-11200    Comprehensive General Chemistry I-II (or equivalent) *	

PHYS 12100-12200	General Physics I-II (or higher) * +	
One of the following sequences:		200
MATH 13100-13200	Elementary Functions and Calculus I-II	
MATH 15100-15200	Calculus I-II	
MATH 16100-16200	Honors Calculus I-II *	
MATH 16110 & MATH 16210	Honors Calculus I (IBL) and Honors Calculus II (IBL) *	
Total Units		400

## MAJOR

One of the following:		100
CHEM 11300	Comprehensive General Chemistry III (or equivalent) *	
PHYS 12300	General Physics III (or higher) * +	
One of the following: **		100
MATH 16300	Honors Calculus III	
MATH 16310	Honors Calculus III (IBL)	
MATH 15910	Introduction to Proofs in Analysis	
MATH 20250	Abstract Linear Algebra	100
One of the following:		300
MATH 20300-20400-20500	Analysis in $R^n$ I-II-III	
MATH 20310-20410-20510	Analysis in $R^n$ I (accelerated); Analysis in $R^n$ II (accelerated); Analysis in $R^n$ III (accelerated)	
MATH 20700-20800-20900	Honors Analysis in $R^n$ I-II-III ^	
Two mathematics courses chosen from the List of Approved Courses		200
Four courses within the PSCD or from CPNS but outside of mathematics, at least two of which should be taken in a single department ***		400
BA Specific		
One of the following:		100
MATH 25400	Basic Algebra I	
MATH 25700	Honors Basic Algebra I	
One of the following:		100
MATH 25500	Basic Algebra II	
MATH 25800	Honors Basic Algebra II	

A course from the List of Approved Courses

Total Units	1400
-------------	------

Summary of Requirements: Mathematics BS

GENERAL EDUCATION

One of the following sequences:	200
---------------------------------	-----

CHEM 10100 & CHEM 10200	Introductory General Chemistry I and Introductory General Chemistry II
----------------------------	---

CHEM 11100-11200	Comprehensive General Chemistry I-II (or equivalent) *
---------------------	--

PHYS 12100-12200	General Physics I-II (or higher) *+
---------------------	-------------------------------------

One of the following sequences:	200
---------------------------------	-----

MATH 13100-13200	Elementary Functions and Calculus I-II
---------------------	--

MATH 15100-15200	Calculus I-II
---------------------	---------------

MATH 16100-16200	Honors Calculus I-II *
---------------------	------------------------

MATH 16110 & MATH 16210	Honors Calculus I (IBL) and Honors Calculus II (IBL)
----------------------------	---

Total Units	400
-------------	-----

MAJOR

One of the following:	100
-----------------------	-----

CHEM 11300	Comprehensive General Chemistry III (or equivalent) *
------------	---

PHYS 12300	General Physics III (or higher) *+
------------	------------------------------------

One of the following: **	100
--------------------------	-----

MATH 16300	Honors Calculus III
------------	---------------------

MATH 16310	Honors Calculus III (IBL)
------------	---------------------------

MATH 15910	Introduction to Proofs in Analysis
------------	------------------------------------

MATH 20250	Abstract Linear Algebra	100
------------	-------------------------	-----

One of the following:	300
-----------------------	-----

MATH 20300-20400-20500	Analysis in $R^n$ I-II-III
---------------------------	----------------------------

MATH 20310-20410-20510	Analysis in $R^n$ I (accelerated); Analysis in $R^n$ II (accelerated); Analysis in $R^n$ III (accelerated)
---------------------------	---

MATH 20700-20800-20900	Honors Analysis in $R^n$ I-II-III ^
---------------------------	-------------------------------------

Two Mathematics courses chosen from the List of Approved Courses	200
--	-----

Four courses within the PSCD or from CPNS but outside of mathematics, at least two of which should be taken in a single department \*\*\* 400

**BS Specific**

One of the following: 200

MATH 25400 Basic Algebra I  
& MATH 25500 and Basic Algebra II

MATH Honors Basic Algebra I-II  
25700-25800

Three courses that are not MATH courses but are either from the same PSCD department or CPNS 300

---

Total Units 1700

\* Credit may be granted by examination.

\*\* Students who complete (or receive credit for) MATH 13300 Elementary Functions and Calculus III or MATH 15300 Calculus III must use these courses as general electives, and MATH 15910 Introduction to Proofs in Analysis must be completed for the major.

\*\*\* May include BIOS 24231 Methods in Computational Neuroscience and BIOS 24232 Computational Approaches to Cognitive Neuroscience, or AP credit for STAT 22000 Statistical Methods and Applications, CHEM 11100 Comprehensive General Chemistry I, and/or PHYS 12100-12200 General Physics I-II. May not include CMSC 10100 Introduction to Programming for the World Wide Web I, CMSC 10200 Introduction to Programming for the World Wide Web II, CMSC 11000 Multimedia Programming as an Interdisciplinary Art I, CMSC 11100 Multimedia Programming as an Interdisciplinary Art II, or CMSC 11200 Introduction to Interactive Logic, or any PHSC course.

+ The sequence PHYS 13100-13200-13300 Mechanics; Electricity and Magnetism; Waves, Optics, and Heat is recommended for mathematics majors.

^ Students who complete MATH 20700 Honors Analysis in Rn I will not be required to take MATH 20250 Abstract Linear Algebra; in its place they will take an additional course from the List of Approved Courses.

### Degree Program in Applied Mathematics

Candidates for the BS in applied mathematics all take prescribed courses in numerical analysis, algebra, complex variables, ordinary differential equations, and partial differential equations. In addition, candidates are required to select, in consultation with one of the departmental counselors, a secondary field, which consists of three additional courses from a single department that is outside the Department of Mathematics but within the Physical Sciences Collegiate Division or among Computational Neuroscience (CPNS) courses.

### Summary of Requirements: BS in Applied Mathematics

#### GENERAL EDUCATION

One of the following: 200



CHEM 10100 & CHEM 10200	Introductory General Chemistry I and Introductory General Chemistry II	
CHEM 11100-11200	Comprehensive General Chemistry I-II (or equivalent) *	
PHYS 12100-12200	General Physics I-II (or higher) * +	
One of the following:		200
MATH 13100-13200	Elementary Functions and Calculus I-II	
MATH 15100-15200	Calculus I-II	
MATH 16100-16200	Honors Calculus I-II *	
MATH 16110 & MATH 16210	Honors Calculus I (IBL) and Honors Calculus II (IBL)	
Total Units		400
MAJOR		
One of the following:		100
CHEM 11300	Comprehensive General Chemistry III (or equivalent) *	
PHYS 12300	General Physics III (or higher) * +	
One of the following: **		100
MATH 16300	Honors Calculus III	
MATH 16310	Honors Calculus III (IBL)	
MATH 15910	Introduction to Proofs in Analysis	
MATH 20250	Abstract Linear Algebra	100
One of the following:		300
MATH 20300-20400-20500	Analysis in $R^n$ I-II-III	
MATH 20310-20410-20510	Analysis in $R^n$ I (accelerated); Analysis in $R^n$ II (accelerated); Analysis in $R^n$ III (accelerated)	
MATH 20700-20800-20900	Honors Analysis in $R^n$ I-II-III	
One of the following:		100
MATH 21100	Basic Numerical Analysis	
MATH 21200	Advanced Numerical Analysis	
One of the following:		100
MATH 25400	Basic Algebra I	
MATH 25700	Honors Basic Algebra I	
All three of the following courses:		300
MATH 27000	Basic Complex Variables	

MATH 27300	Basic Theory of Ordinary Differential Equations	
MATH 27500	Basic Theory of Partial Differential Equations	
Six courses that are not MATH courses but are either within the PSCD or from CPNS, at least three of which should be taken in a single department **		600
Total Units		1700

\* Credit may be granted by examination.

\*\* See restrictions on certain courses listed under previous summary.

+ The sequence PHYS 13100-13200-13300 Mechanics; Electricity and Magnetism; Waves, Optics, and Heat is recommended for mathematics majors.

### Degree Program in Mathematics with Specialization in Economics

This program is a version of the BS in mathematics. The BS degree is in mathematics with the designation "with specialization in economics" included on the final transcript. Candidates are required to complete a yearlong sequence in calculus, MATH 15910 Introduction to Proofs in Analysis if the calculus sequence did not terminate with MATH 16300 Honors Calculus III/MATH 16310 Honors Calculus III (IBL), the one-quarter course MATH 20250 Abstract Linear Algebra, a yearlong sequence in analysis (MATH 20300-20400-20500 Analysis in  $\mathbb{R}^n$  I-II-III or MATH 20310-20410-20510 Analysis in  $\mathbb{R}^n$  I (accelerated); Analysis in  $\mathbb{R}^n$  II (accelerated); Analysis in  $\mathbb{R}^n$  III (accelerated) or MATH 20700-20800-20900 Honors Analysis in  $\mathbb{R}^n$  I-II-III), and one quarter of abstract algebra (MATH 25400 Basic Algebra I or MATH 25700 Honors Basic Algebra I), and earn a grade of at least C- in each course. Students must also take STAT 25100 Introduction to Mathematical Probability or STAT 25150 Introduction to Mathematical Probability-A. The remaining two mathematics courses must be among the following five: MATH 27000 Basic Complex Variables, MATH 27100 Measure and Integration, MATH 27200 Basic Functional Analysis, MATH 27300 Basic Theory of Ordinary Differential Equations, or MATH 23500 Markov Chains, Martingales, and Brownian Motion. A C average or higher must be earned in these two courses.

In addition to the third quarter of basic chemistry or basic physics, the eight courses required outside the Department of Mathematics must include STAT 23400 Statistical Models and Methods or STAT 24400 Statistical Theory and Methods I. The remaining seven courses should be in the Department of Economics and must include ECON 20000-20100-20200 The Elements of Economic Analysis I-II-III or ECON 20010-ECON 20110-ECON 20210 The Elements of Economic Analysis: Honors I-II-III and either ECON 20900 Econometrics: Honors or ECON 21000 Econometrics. The remaining two courses may be chosen from any undergraduate economics course numbered higher than ECON 20210 The Elements of Economic Analysis: Honors III. A University of Chicago Booth School of Business course may be considered for elective credit if the course requires the equivalent of ECON 20100 as a prerequisite and is numbered as a Chicago Booth 40000 or higher course. Additionally, the course needs to pertain to the application of economic theory to a course subject that is not offered by the Department of Economics. Courses such as accounting, investments, and entrepreneurship will not be considered for economics elective

credit. Consideration for elective credit must be done by petition before a student registers for the course. There will be no retroactive consideration for credit. Students must earn a grade of C or higher in each course taken in economics to be eligible for this degree.

It is recommended that students considering graduate work in economics use some of their electives to include at least one programming course (CMSC 15100 Introduction to Computer Science I is strongly recommended) and an additional course in statistics (STAT 24400-24500 Statistical Theory and Methods I-II or STAT 24410 Statistical Theory and Methods Ia and STAT 24500 Statistical Theory and Methods II are appropriate two-quarter sequences). Students planning to apply to graduate economics programs are strongly encouraged to meet with one of the economics undergraduate program directors before the beginning of their third year.

### Summary of Requirements: BS in Mathematics with Specialization in Economics

#### GENERAL EDUCATION

One of the following sequences: 200

CHEM 10100      Introductory General Chemistry I  
& CHEM 10200      and Introductory General Chemistry II

CHEM              Comprehensive General Chemistry I-II (or equivalent) \*  
11100-11200

PHYS              General Physics I-II (or higher) \* +  
12100-12200

One of the following sequences: 200

MATH              Elementary Functions and Calculus I-II  
13100-13200

MATH              Calculus I-II  
15100-15200

MATH              Honors Calculus I-II \*  
16100-16200

MATH 16110      Honors Calculus I (IBL)  
& MATH 16210      and Honors Calculus II (IBL)

Total Units 400

#### MAJOR

One of the following: 100

CHEM 11300      Comprehensive General Chemistry III (or higher) \*

PHYS 12300      General Physics III (or higher) \* +

One of the following: \*\* 100

MATH 16300      Honors Calculus III

MATH 16310      Honors Calculus III (IBL)

MATH 15910      Introduction to Proofs in Analysis

MATH 20250	Abstract Linear Algebra	100
One of the following:		300
MATH 20300-20400-20500	Analysis in $R^n$ I-II-III	
MATH 20310-20410-20510	Analysis in $R^n$ I (accelerated); Analysis in $R^n$ II (accelerated); Analysis in $R^n$ III (accelerated)	
MATH 20700-20800-20900	Honors Analysis in $R^n$ I-II-III	
One of the following:		100
MATH 25400	Basic Algebra I	
MATH 25700	Honors Basic Algebra I	
Two of the following:		200
MATH 27000	Basic Complex Variables	
MATH 27100	Measure and Integration	
MATH 27200	Basic Functional Analysis	
MATH 27300	Basic Theory of Ordinary Differential Equations	
MATH 23500	Markov Chains, Martingales, and Brownian Motion	
One of the following:		100
STAT 25100	Introduction to Mathematical Probability	
STAT 25150	Introduction to Mathematical Probability-A	
One of the following:		100
STAT 23400	Statistical Models and Methods	
STAT 24400	Statistical Theory and Methods I	
STAT 24410	Statistical Theory and Methods Ia	
One of the following:		300
ECON 20000-20100-20200	The Elements of Economic Analysis I-II-III	
ECON 20010-20110-20210	The Elements of Economic Analysis: Honors I-II-III	
One of the following:		100
ECON 21020	Econometrics	
ECON 21030	Econometrics - Honors	
Three Economics courses numbered higher than 20210		300
Total Units		1800

\* Credit may be granted by examination.

\*\* See restrictions on certain courses listed under earlier summary.

+ The sequence PHYS 13100-13200-13300 Mechanics; Electricity and Magnetism; Waves, Optics, and Heat is recommended for mathematics majors.

## Grading

Subject to College grading requirements and grading requirements for the major and with consent of instructor, students (except students who are majoring in mathematics or applied mathematics) may take any mathematics course beyond the second quarter of calculus for either a quality grade or for P/F grading. A Pass grade is given only for work of C- quality or higher.

All courses taken to meet requirements in the mathematics major must be taken for quality grades. A grade of C- or higher must be earned in each calculus, analysis, or algebra course; and an overall grade average of C or higher must be earned in the remaining mathematics courses that a student uses to meet requirements for the major. Students must earn a grade of C or higher in each course taken in economics for the degree in mathematics with a specialization in economics. Mathematics or applied mathematics students may take any 20000-level mathematics courses elected beyond program requirements for P/F grading.

Incompletes are given in the Department of Mathematics only to those students who have done some work of passing quality and who are unable to complete all the course work by the end of the quarter. Arrangements are made between the instructor and the student.

## Honors

The BA or BS with honors is awarded to students who, while meeting requirements for one of the mathematics degrees, also meet the following requirements: (1) a GPA of 3.25 or higher in mathematics courses and a 3.0 or higher overall; (2) no grade below C- and no grade of W in any mathematics course; (3) completion of at least one honors sequence (either MATH 20700-20800-20900 Honors Analysis in Rn I-II-III or MATH 25700-25800-25900 Honors Basic Algebra I-II-III) with grades of B- or higher in each quarter; and (4) completion with a grade of B- or higher of at least five mathematics courses chosen from the list that follows so that at least one course comes from each group (i.e., algebra, analysis, and topology). No course may be used to satisfy both requirement (3) and requirement (4). If both honors sequences are taken, one sequence may be used for requirement (3) and one sequence may be used for up to three of the five courses in requirement (4).

### Algebra Courses

MATH 24100	Topics in Geometry	100
MATH 24200	Algebraic Number Theory	100
MATH 24300	Introduction to Algebraic Curves	100
MATH 24400	Introduction to Algebraic Geometry	100
MATH 25700	Honors Basic Algebra I	100
MATH 25800	Honors Basic Algebra II	100
MATH 25900	Honors Basic Algebra III	100
MATH 26700	Introduction to Representation Theory of Finite Groups	100
MATH 26800	Introduction to Commutative Algebra	100

MATH 27700	Mathematical Logic I	100
MATH 27800	Mathematical Logic II	100
MATH 28410	Honors Combinatorics	100
MATH 32500	Algebra I	100
MATH 32600	Algebra II	100
MATH 32700	Algebra III	100

**Analysis Courses**

MATH 20700	Honors Analysis in $\mathbb{R}^n$ I	100
MATH 20800	Honors Analysis in $\mathbb{R}^n$ II	100
MATH 20900	Honors Analysis in $\mathbb{R}^n$ III	100
MATH 23500	Markov Chains, Martingales, and Brownian Motion	100
MATH 27000	Basic Complex Variables	100
MATH 27100	Measure and Integration	100
MATH 27200	Basic Functional Analysis	100
MATH 27300	Basic Theory of Ordinary Differential Equations	100
MATH 27400	Introduction to Differentiable Manifolds and Integration on Manifolds	100
MATH 27500	Basic Theory of Partial Differential Equations	100
MATH 31200	Analysis I	100
MATH 31300	Analysis II	100
MATH 31400	Analysis III	100

**Topology Courses**

MATH 26200	Point-Set Topology	100
MATH 26300	Introduction to Algebraic Topology	100
MATH 31700	Topology and Geometry I	100
MATH 31800	Topology and Geometry II	100
MATH 31900	Topology and Geometry III	100

With departmental approval, MATH 29700 Proseminar in Mathematics, or any course(s) in the Paris Mathematics Program, may be chosen so that it falls in one of the three groups. One of the three Paris courses each year will be designated as a replacement for MATH 25900 Honors Basic Algebra III for candidates who are working toward graduation with honors. Courses taken for the honors requirements (3) and (4) also may be counted toward courses taken to meet requirements for the major. Students who wish to be considered for honors should consult with one of the departmental counselors no later than Spring Quarter of their third year.

## Minor Program in Mathematics

The minor in mathematics requires a total of six or seven courses in mathematics, depending on whether or not MATH 16300 Honors Calculus III or MATH 16310 Honors Calculus III (IBL) is required in another degree program. If it is not used elsewhere, MATH 16300 Honors Calculus III or MATH 16310 Honors Calculus III (IBL) must be included in the minor, for a total of seven courses. The remaining six courses must include the linear algebra course MATH 20250 Abstract Linear Algebra, a three-course sequence in analysis MATH 20300-20400-20500 Analysis in Rn I-II-III or MATH 20310-20410-20510 Analysis in Rn I (accelerated); Analysis in Rn II (accelerated); Analysis in Rn III (accelerated) or MATH 20700-20800-20900 Honors Analysis in Rn I-II-III), and the first course in one of the algebra sequences (MATH 25400 Basic Algebra I or MATH 25700 Honors Basic Algebra I). The sixth course may be chosen from either the second course in one of the algebra sequences (MATH 25500 Basic Algebra II or MATH 25800 Honors Basic Algebra II) or a mathematics course numbered 23000 or higher chosen in consultation with the director of undergraduate studies or one of the departmental counselors. A student who completes MATH 20700 Honors Analysis in Rn I is not obligated to take MATH 20250 Abstract Linear Algebra, but should instead select another mathematics course numbered 23000 or higher. Under special circumstances and to avoid double counting, students may also use mathematics courses numbered 23000 or higher to substitute for up to two quarters of analysis or algebra, if these are required in another degree program.

No course in the minor can be double counted with the student's major(s) or with other minors; nor can it be counted toward general education requirements. Students must earn a grade of at least C- in each of the courses in the mathematics minor. More than one-half of the requirements for a minor must be met by registering for courses bearing University of Chicago course numbers.

Students must meet with the director of undergraduate studies or one of the departmental counselors by Spring Quarter of their third year to declare their intention to complete a minor program in mathematics and to obtain approval for the minor on a form obtained from their College adviser. Courses for the minor are chosen in consultation with the director of undergraduate studies or one of the departmental counselors.

## Paris Mathematics Program (<http://study-abroad.uchicago.edu/programs/paris-mathematics>)

Each Spring Quarter, the Department of Mathematics offers a study abroad opportunity for students to take upper-level mathematics electives at the University's Center in Paris. Departmental faculty offer three successive three-week courses in specialized topics, and students also take a French language course from local French faculty. Students should have completed one of the analysis sequences (MATH 20300-20400-20500 Analysis in Rn I-II-III or MATH 20310-20410-20510 Analysis in Rn I (accelerated); Analysis in Rn II (accelerated); Analysis in Rn III (accelerated) or MATH 20700-20800-20900 Honors Analysis in Rn I-II-III) and at least one quarter of one of the algebra sequences (MATH 25400 Basic Algebra I or MATH 25700 Honors Basic Algebra I) before attending the Paris

program. Applications are due the prior Spring Quarter and should be submitted to the Study Abroad office.

### Joint Degree Programs

#### BA/MS or BS/MS in Mathematics

Qualified College students may receive both a bachelor's and a master's degree in mathematics concurrently at the end of their studies in the College. Qualification consists of satisfying all requirements of each degree in mathematics. To be eligible for the joint program, a student must excel on the Calculus Accreditation Examination and must begin MATH 20700 Honors Analysis in  $\mathbb{R}^n$  I in the Autumn Quarter of the student's first year. By following a program of prescribed undergraduate course sequences in mathematics and succeeding in all courses with grades no lower than A-, the student becomes eligible to enroll in graduate courses in mathematics in the student's third year. While only a few students complete the joint BA/MS program, many undergraduates enroll in graduate-level mathematics courses. Admission to all mathematics graduate courses requires prior written consent of the director or co-director of undergraduate studies.

Students should submit their application for the joint program to one of the departmental counselors as soon as possible, but no later than the Winter Quarter of their third year.







## Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Times was used instead of Trajan.

Times was used instead of Palatino.

The editor may contact Leepfrog for a draft with the correct fonts in place.