

## Mathematics, B.A.

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The study of mathematics develops logical thinking, creative problem solving, and the ability to connect ideas. This makes it highly useful and desired for diverse career paths, ranging from graduate study in mathematics, science and engineering careers, through social science, medical, and business careers. Beyond this practical aspect, studying mathematics develops appreciation for the inherent elegance and beauty of the subject and is thus a deeply rewarding endeavor.

The program in mathematics offers courses of study leading to either a minor, or a major in one of several concentrations. The prerequisites to declare and the requirements to complete the major are provided below. For minor program and requirement information please visit the [minor program page](#). The Department, of Mathematics website (<https://math.virginia.edu/>) provides extensive further information, including background and benefits of the various concentrations, student resources, departmental procedures, and advice on navigating the program and beyond.

### Universal Curriculum Requirements

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To be awarded a degree from the College of Arts and Sciences, students are required to complete universal curriculum requirements in addition to the program requirements provided below. The school universal curriculum requirements can be found on the school [Degree Programs page](#).

### Prerequisite

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To declare the major, students must demonstrate proficiency in single and multivariable calculus at the grade level of C or better. Select one of the following options to meet this prerequisite:

- [MATH 2310 - Calculus III](#) Credits: 4  
*Note:* Students may need to complete one or both of MATH 1310 -Calculus I and MATH 1320 -Calculus II prior to enrolling in Calculus III. Students should determine their appropriate starting placement in the calculus sequence by consulting with advisors and placement resources on the Department of Mathematics website.
- [MATH 2315 - Advanced Calculus and Linear Algebra I](#) Credits: 4
- [APMA 2120 - Multivariable Calculus](#) Credits: 4
- Complete a course of study at another university or program that the Director of Undergraduate Programs determines is equivalent to one of the above options.

*Notes:*

1. The sequence MATH 1210, 1220 (Survey of Calculus I and II) is insufficient preparation for continuing to Calculus III and should therefore not be taken by students who might want to major/minor in mathematics or any other field requiring Calculus III or beyond.
2. The above prerequisite is not part of the major itself. Prerequisite courses do not, factor into the major GPA, are not subject to restrictions on transfer credit, double counting, or other rules pertaining to credit applied to the major.

### Program Requirements

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To complete the major, students must complete the requirements for one of the Concentrations or General Option below.

- Each concentration and the general option requires four core courses (the standard or the advanced core), and a set of required and/or elective courses.
- At least 6 courses offered for the major must have a MATH prefix.

- All classes used to complete the major must be taken for a letter grade and passed with a C or better, except that two of these may be passed with a C- or better.

### Restrictions & Exceptions

- No more than two courses taken from outside the University can be applied to the major or minor.
- For transfer students, more may be approved by the Director of the Undergraduate Program and transfer credit advisor.

## Core Requirement

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The core requirement consists of 4 courses, one each in differential equations, linear algebra, real analysis, and abstract algebra. The standard core is satisfied by either standard or advanced versions of these courses. The advanced core requires the advanced version for some of these courses.

### Standard Core

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**Note:** MATH 3315 must be passed at B- or higher to be used as a core course. If MATH 3315 is used to satisfy both the linear algebra and differential equations requirements of the standard core, then an additional MATH elective is required for the concentration so that the total number of MATH courses is not reduced.

#### Differential Equations

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**Select one of the following**

- [MATH 3250 - Ordinary Differential Equations](#) Credits: 4
- [MATH 4250 - Differential Equations and Dynamical Systems](#) Credits: 3
- [MATH 3315 - Advanced Calculus and Linear Algebra II](#) Credits: 4

#### Linear Algebra

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**Select one of the following**

- [MATH 3351 - Elementary Linear Algebra](#) Credits: 3
- [MATH 4651 - Advanced Linear Algebra](#) Credits: 3
- [MATH 3315 - Advanced Calculus and Linear Algebra II](#) Credits: 4

#### Real Analysis

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**Select one of the following**

- [MATH 3310 - Basic Real Analysis](#) Credits: 4
- [MATH 4310 - Introduction to Real Analysis](#) Credits: 3

#### Abstract Algebra

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**Select one of the following**

- [MATH 3354 - Survey of Algebra](#) Credits: 3
- [MATH 4652 - Introduction to Abstract Algebra](#) Credits: 3

### Advanced Core

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**Note:** MATH 3315 must be passed at B- or higher to be used as a core course.

#### Differential Equations

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**Select one of the following**

- [MATH 3250 - Ordinary Differential Equations](#) Credits: 4
- [MATH 4250 - Differential Equations and Dynamical Systems](#) Credits: 3
- [MATH 3315 - Advanced Calculus and Linear Algebra II](#) Credits: 4

**Linear Algebra**

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- [MATH 4651 - Advanced Linear Algebra](#) Credits: 3

**Real Analysis**

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- [MATH 4310 - Introduction to Real Analysis](#) Credits: 3

**Abstract Algebra**

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- [MATH 4652 - Introduction to Abstract Algebra](#) Credits: 3

**General Option Requirements**

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- 4 courses from the Standard Core.
- 2 MATH elective (see below).
- 3 General electives (see below).
- 1 Computing elective (see below).

**Concentrations Requirements**

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**Graduate Preparatory**

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- 4 courses from the Advanced Core.
- [MATH 3340 - Complex Variables with Applications](#) Credits: 3
- 1 MATH elective (see below).
- 3 General electives (see below).
- 1 Computing elective (see below).

**Probability and Statistics**

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- 4 courses from the Standard Core.
- [MATH 3100 - Introduction to Probability](#) Credits: 3
- [MATH 4110 - Introduction to Stochastic Processes](#) Credits: 3
- [STAT 3120 - Introduction to Mathematical Statistics](#) Credits: 3
- 2 General electives (see below).
- 1 Computing elective (see below).

**Financial Mathematics**

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- 4 courses from the Standard Core.
- [MATH 3100 - Introduction to Probability](#) Credits: 3
- [MATH 4140 - Mathematics of Derivative Securities](#) Credits: 3
- [STAT 3120 - Introduction to Mathematical Statistics](#) Credits: 3
- 2 General electives (see below).
- 2 Finance electives (see below).

- 1 Computing elective (see below).

## Teacher Education

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- 4 courses from the Standard Core.
- [MATH 3100 - Introduction to Probability](#) Credits: 3
- [MATH 4040 - Discrete Mathematics](#) Credits: 3
- MATH 5700 - Introduction to Geometry Credits: 3
- [STAT 3120 - Introduction to Mathematical Statistics](#) Credits: 3
- 1 General elective (see below).
- 1 Computing elective (see below).

## MATH Electives

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Any course with a MATH prefix numbered 3000 or higher (excluding MATH 3350), that is not being used to satisfy another requirement of the major.

## General Electives

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- [CS 3100 - Data Structures and Algorithms 2](#) Credits: 3
- [CS 3102 - Theory of Computation](#) Credits: 3
- [ECON 4010 - Game Theory](#) Credits: 3
- PHIL 5420 - Advanced Logic Credits: 3
- PHIL 5470 - Philosophy of Mathematics Credits: 3
- [STAT 3120 - Introduction to Mathematical Statistics](#) Credits: 3
- STAT 5265 - Investment Science I Credits: 3
- [SYS 3021 - Deterministic Decision Models](#) Credits: 3
- [SYS 3060 - Stochastic Decision Models](#) Credits: 3

## Finance Electives

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- [COMM 2010 - Introduction to Financial Accounting](#) Credits: 3
- [COMM 2020 - Introduction to Management Accounting](#) Credits: 3
- [ECON 2010 - Principles of Economics: Microeconomics](#) Credits: 3
- [ECON 2020 - Principles of Economics: Macroeconomics](#) Credits: 3

## Computing Electives

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- [CS 1110 - Introduction to Programming](#) Credits: 3
- [CS 1111 - Introduction to Programming](#) Credits: 3
- [CS 1112 - Introduction to Programming](#) Credits: 3
- [CS 1113 - Introduction to Programming](#) Credits: 3
- [CS 1120 - Introduction to Computing: Explorations in Language, Logic, and Machines](#) Credits: 3
- [PHYS 2660 - Fundamentals of Scientific Computing](#) Credits: 3

## Substitutions

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The following APMA courses may be substituted for certain requirements of the major. However, students must still take the required minimum number of MATH prefix courses to earn the major.

- APMA 2130 for MATH 3250
- APMA 3080 for MATH 3351

- APMA 3100 for MATH 3100
- APMA 3120 for STAT 3120

## Distinguished Majors Program

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In order to complete the Distinguished Majors Program, students must have completed all prerequisites, apply, and be admitted to the program by the May prior to the last two semesters of undergraduate study.

### Program Requirements

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- Fulfill all requirements of the chosen major concentration or general option.

### DMP Requirements

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- Complete the following courses with a GPA of at least 3.4 and a minimum grade of B in each course. These courses may also be used to satisfy major requirements.
- [MATH 3340 - Complex Variables with Applications](#) Credits: 3
- [MATH 4310 - Introduction to Real Analysis](#) Credits: 3
- [MATH 4651 - Advanced Linear Algebra](#) Credits: 3
- [MATH 4652 - Introduction to Abstract Algebra](#) Credits: 3
- [MATH 4770 - General Topology](#) Credits: 3
- [MATH 4840 - Introduction to Mathematical Research](#) Credits: 3
- [MATH 4330 - Calculus on Manifolds](#) Credits: 3
- OR
- [MATH 4720 - Introduction to Differential Geometry](#) Credits: 3

### Thesis Requirement

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- Complete the following by writing a Distinguished Major Thesis under the supervision of a faculty advisor.
- [MATH 4900 - Distinguished Major Thesis](#) Credits: 3
- [MATH 4901 - Distinguished Major Thesis](#) Credits: 3
- Successfully defend the thesis (public presentation followed by closed Q&A examination with the thesis committee) by the last day of classes of the final semester.

## Learning Objectives

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A student who completes the major will have a solid foundation in the core topics of modern mathematics, more extensive knowledge in a chosen concentration, familiarity of appropriate adjacent fields, and familiarity with computing. The math major will be *proficient* in each of the following 4 areas:

1. **Communication** - read, interpret, write about, and talk about mathematics, in a manner appropriate to the audience and purpose; recognize and construct logical arguments and rigorous proofs; understand the differences between proofs and other less formal arguments;
2. **Problem solving and computation** - devise problem solving strategies; carry out computations and derivations accurately and efficiently; assess the correctness of solutions; create and explore examples; carry out mathematical experiments, and devise and test conjectures;
3. **Abstraction** - work with abstract mathematical structures, generalize from the concrete to the abstract, deduce general principles from particular instances;
4. **Mathematical maturity** - absorb new mathematical ideas efficiently; link theory with examples and applications; exhibit independence and perseverance; approach open-ended inquiry with curiosity and creativity.