MATHEMATICS, BACHELOR OF ARTS

Math Course Placement and Sequencing for All Homewood Students

There are three different versions of single variable calculus offered by the Mathematics Department, including 2 versions of semester courses in Calculus I and II, roughly equivalent to Calculus AB and BC in the College Board's Advanced Placement (AP) system, and a single semester honors version encompassing both Calculus I and II. Students should select their first course in mathematics at JHU based on their intended areas of study, prior experience and training in mathematics, and the results of an advisory Placement Exam offered to incoming freshmen. Students intending to major in mathematics, the natural sciences, or engineering, or who are interested in studying mathematics beyond a year of single variable calculus are strongly encouraged to begin with the AS.110.108 Calculus I (Physical Sciences & Engineering) - AS.110.109 Calculus II (For Physical Sciences and Engineering) sequence or AS.110.113 Honors Single Variable Calculus. Students majoring in other subjects, or who do not intend to continue taking mathematics courses beyond a year of calculus, may wish to take the sequence AS.110.106 Calculus I (Biology and Social Sciences) - AS.110.107 Calculus II (For Biological and Social Science). This latter sequence relates the methods of calculus to the biological and social sciences. A one-semester pre-calculus course (AS.110.105 Precalculus) is a pre-calculus course offered for students who would benefit from additional preparation in the basic tools (algebra, trigonometry and the properties of functions) used in calculus.

Entering students may receive course credit for Calculus I or Calculus I and II on the basis of the performance level on either the (AP) or International Baccalaureate (IB) exams (https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/undergraduate-policies/academic-policies/external-credit/). All students, regardless of completion of advanced placement exams previously, must take a departmental placement exam to determine their appropriate first course in mathematics. Additional placement information can be found here (http://mathematics.jhu.edu/undergraduate/placement-exams/).

After completing a full year of calculus, the courses AS.110.201 Linear Algebra, AS.110.202 Calculus III, or AS.110.302 Differential Equations and Applications may be taken in any order. The department offers honors courses of the former 2; AS.110.212 Honors Linear Algebra and AS.110.211 Honors Multivariable Calculus.

Mathematics Major Requirements

(Also see Requirements for a Bachelor's Degree (https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/undergraduate-policies/academic-policies/requirements-for-a-bachelors-degree/).)

The undergraduate program in the Department of Mathematics is intended both for students interested in preparing for graduate study and research in pure mathematics, and for students interested in using mathematics to pose and solve problems in the sciences, engineering, social sciences, or other areas. Undergraduate mathematics majors will study:

- The foundations of analysis, which begins with the study of functions and their derivatives and integrals
- The fundamentals of advanced algebra, which is based on axiomatic systems involving operations of addition and multiplication in general settings
- Additional subjects such as geometry, probability, and topology
- Applications of mathematics to science and/or engineering.

A candidate for the Bachelor of Arts Degree in Mathematics is required to have completed the major requirements listed below. All courses used to meet these requirements must be completed with a grade of C- or better and may not be taken satisfactory/unsatisfactory (S/U) grading scheme.

Code	Title	Credits
AS.110.106	Calculus I (Biology and Social Sciences)	4
or AS.110.108	Calculus I (Physical Sciences & Engineering)	
AS.110.107	Calculus II (For Biological and Social Science) [1]	4
or AS.110.113	Honors Single Variable Calculus	
or AS.110.109	Calculus II (For Physical Sciences and Engineering)	
AS.110.202	Calculus III [2]	4
or AS.110.211	Honors Multivariable Calculus	
AS.110.201	Linear Algebra [2]	4
or AS.110.212	Honors Linear Algebra	
AS.110.401	Introduction to Abstract Algebra	4
or AS.110.411	Honors Algebra I	
AS.110.304	Elementary Number Theory [2]	4
or AS.110.412	Honors Algebra II	
or AS.110.413	Introduction To Topology	
or AS.110.422	Representation Theory	
or AS.110.435	Introduction to Algebraic Geometry	
AS.110.405	Real Analysis I [2]	4
or AS.110.415	Honors Analysis I	
AS.110.311	Methods of Complex Analysis	4
or AS.110.406	Real Analysis II	
or AS.110.407	Honors Complex Analysis	
or AS.110.413	Introduction To Topology	
or AS.110.416	Honors Analysis II	
or AS.110.417	Partial Differential Equations	
or AS.110.421	Dynamical Systems	
or AS.110.439	Introduction To Differential Geometry	
or AS.110.441	Calculus on Manifolds	
or AS.110.443	Fourier Analysis	
One 300-level or higher math course		4
Two courses in any one of the approved applications of mathematics or other courses approved by the Director of Undergraduate Studies. [4]		8
Total Credits		**44**

1 Honors Single Variable is a single 4 credit course that will count toward the major or minor in mathematics as both Calculus I and Calculus II.

2 Majors are encouraged but not required to take honors variant.

3 AS.110.413 Introduction To Topology cannot be used for more than one requirement.

4 See table below for some examples of approved application courses. All other choices must be approved by the Director of Undergraduate Studies, and must be upper-level, quantitative in nature, and both from the same department or program.

Approved Courses in Areas of Application

Code	Title	Credits
Physics		
AS.171.204	Classical Mechanics II	4
AS.171.301	Electromagnetic Theory II	4
AS.171.303	Quantum Mechanics I	4
AS.171.304	Quantum Mechanics II	4
AS.171.312	Statistical Physics/Thermodynamics	4
Chemistry		
AS.030.302	Physical Chemistry II	3
AS.030.453	Intermediate Quantum Chemistry	3
Economics		
AS.180.301	Microeconomic Theory	4
AS.180.302	Macroeconomic Theory	4
AS.180.334	Econometrics	3
AS.180.434	Advanced Econometrics	3
Computer Science		
EN.601.231	Automata & Computation Theory	3
EN.601.433	Intro Algorithms	3
EN.601.442	Modern Cryptography	3
EN.601.457	Computer Graphics	3
EN.601.461	Computer Vision	3
EN.601.464	Artificial Intelligence	3
EN.601.475	Machine Learning	3
EN.601.476	Machine Learning: Data to Models	3
Applied Mathematics and Statistics		
EN.553.361	Introduction to Optimization	4
EN.553.362	Introduction to Optimization II	4
EN.553.391	Dynamical Systems	4
EN.553.420	Introduction to Probability	4
EN.553.426	Introduction to Stochastic Processes	4
EN.553.430	Introduction to Statistics	4
EN.553.453	Mathematical Game Theory	4
EN.553.465	Introduction to Convexity	4
EN.553.471	Combinatorial Analysis	4
EN.553.472	Graph Theory	4
EN.553.481	Numerical Analysis	4
EN.553.492	Mathematical Biology	3
EN.553.493	Mathematical Image Analysis	4
Philosophy		
AS.150.420	Mathematical Logic I	3
AS.150.421	Mathematical Logic II	3
AS.150.422	Axiomatic Set Theory	3

Sample Program of Study

The following chart is one example of how a student might progress through the mathematics major. As potential math majors enter JHU with a wide range of prior math abilities, students should begin courses at their current level of knowledge.

First Year

First Semester	Credits	Second Semester	Credits
AS.110.108	4	AS.110.109	4
	4		**4**

Second Year

First Semester	Credits	Second Semester	Credits
AS.110.202 or 211	4	AS.110.201 or 212	4
		AS.110.302 (or other 300+ level elective)	4
	4		**8**

Third Year

First Semester	Credits	Second Semester	Credits
AS.110.405 or 415	4	AS.110.406 or 416	4
Math application course	3-4		
	7-8		**4**

Fourth Year

First Semester	Credits	Second Semester	Credits
AS.110.401	4	AS.110.304	4
		Math application course	3-4
	4		**7-8**

Total Credits 42-44

Honors Program in Mathematics

As a general guideline, departmental honors are awarded to recipients of the B.A. degree who have completed the following with a combined GPA of at least 3.6 out of 4.0:

- AS.110.415 Honors Analysis I and AS.110.416 Honors Analysis II,
- AS.110.411 Honors Algebra I, and AS.110.412 Honors Algebra II,
- AS.110.411 Honors Algebra I, or AS.110.412 Honors Algebra II, and AS.110.407 Honors Complex Analysis
- and one more course at the 400-level or above with a combined grade point average of at least 3.6/4.0.

J.J. Sylvester Prize

The J.J. Sylvester Prize in Mathematics, which carries a cash award, is given each year to the one of two top-performing graduating seniors majoring in mathematics for outstanding achievement.

Undergraduate Teaching Assistantships

The department awards many upper-level undergraduates the opportunity to act as recitation instructors to our freshman courses. This award enables a student to practice the art of teaching and communicating mathematics in an environment where they are hired as a formal instructor to aid the professor of a regular curriculum course as a Teaching Assistant (TA). Undergraduate TAs are fully mentored and monitored, and the position provides a valuable credential and experience.

Undergraduate Learning Goals

At the time of graduation, math majors should:

- Have a good working knowledge of the language of mathematics as embodied in the basic constructs of mathematics in the fundamental areas of algebra, analysis, and geometry
- Be able to analyze the logical structure of a scientific or mathematical problem and to develop a meaningful approach to a solution

- Be able to read, understand, and construct a well-formed proof
- Develop the mathematical maturity and skills necessary to extend their knowledge through self-study and independent research
- Be able to apply mathematical methods to solve research problems arising outside of mathematics
- Be able to formulate precise mathematical statements and questions
- Be able to effectively and successfully communicate mathematics in both oral and written form to a broad mathematical and lay audience.