

MATHEMATICS

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Mathematics is universal, beautiful, and practical.

The mathematics faculty at Pacific University is dedicated to creating a welcoming environment in which every student can develop and apply analytical skills, computational fluency, and mathematical knowledge in diverse contexts. We strive to help our students appreciate mathematics as a creative endeavor and engage in the world as productive, critical-thinking citizens.

The Mathematics major provides students a strong mathematics foundation with emphases in several key areas including analysis, abstract algebra and applied mathematics. Students completing this major typically pursue careers in applied mathematics, enter graduate programs in mathematics and other fields, and complete certification requirements to teach mathematics in K-12 (see the Education section of this catalog for more details).

The department maintains common goals for all of its students (majors, minors and others). Students in our courses will learn strategies for abstract problem solving, gain a basic understanding of computers and the broad implications of their use, be exposed to mathematics as a liberal art, and be given the opportunity to hone their computational skills.

Students with a program of study in Mathematics learn abstract mathematical constructs and paradigms. They develop logical thinking and communication skills through argumentation and proof. Students study methods of mathematical modeling, and develop confidence and competence in developing models and carrying out algorithms. Students learn to read and speak the language of mathematics. Graduates of our program have gone on to engage in a wide variety of post-graduate activities, including work in mathematics and science-related fields or graduate study in mathematics or education

Program Learning Outcomes

The Pacific University Mathematics Program introduces students to mathematics as a unique mode of inquiry, a rigorous and highly creative endeavor, characterized by powerful utility as well as profound beauty. To this end, our goals are to promote, at all levels of our curriculum:

- Computational and quantitative fluency
 - Students will master mathematical notation and computational tasks at levels commensurate with their academic major and professional goals.
 - Students will interpret and express graphical and algebraic representations of quantitative information, and will be able to translate between these representations.
 - Students will display algorithmic literacy in their construction, execution, and analysis, of problem-solving and calculation routines.
- Logical reasoning and critical thought
 - Students will appreciate the precision required in formulating definitions, mathematical statements, and logical implications within an axiomatic system.
 - Students will adhere to this precision and rigorous logical reasoning in their own constructions and critiques of formal mathematical proofs.
- Abstraction and generalization
 - Students will import the mathematical techniques used in particular example problems into the context of more general problems.
 - Students will recognize how abstract study of a mathematical object's properties allows one to situate that object, and related mathematical theory, in more general settings.
- Applications of mathematics
 - Students will explore the utility of mathematics as a powerful computational tool in the natural and social sciences.
 - Students will translate problems from across disciplines into mathematical models, allowing for the leveraging of sophisticated mathematical theory that often lends new insight into these problems, and as a lens through which one gains novel perspectives on a variety of practical problems.
- Communication
 - Students will appreciate and demonstrate the uniquely mathematical style of communication whose hallmarks are clarity, concision, and rigorous logic.
 - Students will effectively communicate complex mathematical ideas and carefully reasoned arguments both orally and in writing to a range of audiences.
- Mathematics as a liberal art
 - Students will recognize the important philosophical, cultural, and historical contributions of mathematical ideas.
 - Students will appreciate mathematics for its own sake, reveling in the beauty and philosophical recreations that its study affords.
- Career Development
 - Teach mathematics majors and minors the knowledge that will enable them to pursue challenging careers in academia, industry, government, business, and education.
 - Provide students with the mathematical foundation required for graduate work in mathematics, statistics, medicine, law, engineering, and natural and social sciences.
 - Prepare undergraduates across the college for success in their chosen careers through the development of logical and critical-thinking skills.

Mathematics: Requirements for the Major

Core requirements:

<u>Calculus</u>		12 credits
Math 226	Calculus I	
Math 227	Calculus II	
Math 228	Calculus III	
<u>Intermediate Courses</u>		12 credits
Math 240	Discrete Mathematics	

Math 306	Linear Algebra	
Math 326	Introduction to Analysis	
<u>Support</u>		8 credits
CS 150	Introduction to Computer Science I	
Four credits from:		
ECON 102	Economics of Markets & Governments	
CHEM 220	General Chemistry I	
PHY 232	General Physics I	
CS 310	Theoretical Computer Science	
<u>Advanced Topics</u>		12 credits
Additional Math at the 300 or 400 level, at least 4 of which must be at the 400 level		
<u>Capstone</u>		2 credits
Math 490	Senior Capstone	
Math 492	Senior Capstone II	
Total		46 credits

Restriction: At most one course passed with a grade below "C-" can count toward the mathematics major.

Optional Specializations

These specializations are optional and not required to receive a major in mathematics. Courses can be used to satisfy both requirements for the mathematics major and an optional specialization.

Students whose career goal is in financial mathematics or the actuarial field should complete the Actuarial Science specialization. Students who will be attending graduate school in mathematics should complete the Advanced Mathematics specialization. Students interested in a career in mathematical biology should complete the Biomathematics specialization. And, students who intend to become high school teachers should complete the Secondary Mathematics Education specialization.

Students completing a specialization are well served by using some of the courses in the specialization to satisfy requirements for the core major.

Actuarial Science

MATH 316	Mathematical Statistics
ECON 101	Economics of Social Issues
ECON 102	Economics of Markets and Governments
BA 201	Accounting Principles
BA 305	Business Finance

One of the following:

BA 306	Business Law
BA 345	Corporate Finance
BA 445	Financial Modeling and valuation
ECON 321	Econometrics

Advanced Mathematics

MATH 311	Ordinary Differential Equations
MATH 402	Abstract Algebra
MATH 405	Real Analysis

Two more courses from among:

MATH 316	Mathematical Statistics
MATH 321	Higher Geometry
MATH 400	Number Theory
MATH 410	Discrete Topics
MATH 411	Partial Differential Equations
MATH 412	Complex Analysis

Biomathematics

MATH 301 Mathematical Modeling

MATH 207 and MATH 316 General Elementary Statistics and Mathematical Statistics

OR

MATH 316 and MATH 410 Mathematical Statistics and Discrete Topics

OR

MATH 311 and MATH 411 Ordinary Differential Equations and Partial Differential Equations

One of the following:

BOIL 200 and BIOL 200L	Flow of Energy and lab
BOIL 201 and BIOL 201L	Flow of Biological Information

Eight additional credits of BIOL at the 200 level or above with advisor approval

Secondary Mathematics Education

MATH 207 General Elementary Statistics

MATH 311 Ordinary Differential Equations

MATH 316 Mathematical Statistics

MATH 321 Higher Geometry

Restriction: At most one course passed with a grade below "C-" can count toward a specialization

Mathematics: Requirements for the Minor

Core Mathematics: 12 credits

MATH 226 & 227

MATH 240

Calculus I & II

Discrete Mathematics

8 credits

4 credits

Electives: 12 credits

8 additional credits of Mathematics numbered 300 or higher.

4 additional credits selected from among CS 150, and Mathematics courses numbered 200 or higher, excluding MATH 221 and MATH 223.

TOTAL: 24 credits

Restriction: At most one course passed with a grade below "C-" can count towards the mathematics minor.

COURSES

MATH-122 College Algebra

Offers students the opportunity to polish their general algebra skills in preparation for precalculus, statistics and other courses where a working knowledge of algebra without trigonometry is a prerequisite. Throughout the course, students are asked to translate information back and forth between grammatical and mathematical forms. Topics include modeling, graphing, and analysis with linear, quadratic and general polynomial expressions, solving linear, quadratic and general polynomial equations and inequalities and functions. 4 credits.

MATH-125 Precalculus

Most science and mathematics courses require that students be comfortable working with functions symbolically, graphically, and numerically. Precalculus offers students the background they need to pursue these courses. An integral component of the course is translating information back and forth between grammatical and mathematical forms. Concentrating on functions and their properties, the course includes the study of several classes of functions including polynomial, rational, exponential, logarithmic, and trigonometric functions. The conic sections are also studied. Prerequisite: MATH 122 with a minimum grade of C or placement. 4 credits.

MATH-155 Special Topics in Mathematics

Go to <https://www.pacificu.edu/about-us/centers-institutes/advising-center/new-topics-travel-class-descriptions> or see the Advising Center.

MATH-165 Modern Topics in Mathematics

This course exposes students to abstraction and problem solving with mathematical constructs. Elements of descriptive and inferential statistics give students the foundation to understand visual and numerical representations of data and to make informed judgments about survey and experimental study results. Various topics chosen from among management science, finance, voting theory, game theory, symmetry, proportionality, or other modern topics offer the opportunity to see connections of mathematics to business, political science, art and other fields. 4 credits.

MATH-195 Independent Study

See department for details. Independent study contract required.

MATH-207 General Elementary Statistics

This course covers the basic theory and practice of descriptive and inferential statistics including the presentation and structure of data sets, histograms, correlation, and regression analysis. Sampling distributions, binomial, normal, and chi-square probability distributions, confidence intervals, estimation, and hypothesis testing including t-tests and analysis of variance will also be discussed. Includes an introduction to a statistical software package. Prerequisite: MATH 122 with a minimum grade of C or placement. 4 credits.

MATH-212 Language and Logic

A survey of formal syntactic and semantic features of language, including topics such as sentential logic, predicate logic, axiomatic systems and set theory, and nonclassical extensions such as multivalued logics. Also listed as PHIL 212. Offered annually. 4 credits.

MATH-221 Mathematics for Elementary Teachers I

Designed for future elementary teachers. Elements of logic, numeration, the number systems of arithmetic, elementary number theory, the algorithms of arithmetic, introductory concepts of statistics and probability. Alternate years 2014-2015. 4 credits.

MATH-223 Mathematics for Elementary Teachers II

Designed for future elementary teachers. Intuitive geometry in two and three dimensions, systems of measurement, estimation and approximation. Alternate years 2015-2016. 4 credits.

MATH-226 Calculus I

The study of functions and their rates of change. Topics include the concept of derivative as rate of change, limits and continuity, differentiation and its applications, Intermediate, Extreme and Mean Value Theorems, introduction to integrals, and the Fundamental Theorem of Calculus. Prerequisite: MATH 125 with a minimum grade of C or placement. 4 credits.

MATH-227 Calculus II

Investigation of single variable integration including techniques of symbolic integration, numerical integration and error analysis, applications of integration, and improper integrals. Infinite sequences, infinite series, and Taylor series will be introduced. Prerequisite: MATH 226 with a minimum grade of C or placement. 4 credits.

MATH-228 Calculus III

The study of calculus of several variables. Topics include visualization techniques, vectors and solid analytic geometry, vector arithmetic, partial differentiation and its applications, gradients, optimization techniques, iterated integrals, line integrals, divergence, curl and related theorems. Prerequisite: MATH 227 with a minimum grade of C. 4 credits.

MATH-240 Discrete Mathematics

This course introduces the fundamentals of number systems, sets, functions and relations, logic and proof, elementary combinatorics, Boolean algebra and graph theory. It plays the role of a transition course for mathematics majors, moving them from calculus to the upper division courses in mathematics, and as an important course in logic for computer science majors. Prerequisite: MATH 226 with a minimum grade of C or placement. 4 credits.

MATH-255 Special Topics

Go to <https://www.pacificu.edu/about-us/centers-institutes/advising-center/new-topics-travel-class-descriptions> or see the Advising Center.

MATH-275 Internship

See department for details. Internship contract required. 1-4 credits.

MATH-301 Mathematical Modeling

A wide variety of physical and social systems can be described and analyzed using mathematics. In this course, students will learn about the mathematical modeling process through examination and analysis of frequently used models in physics, chemistry, biology and other sciences. Students will also experience generating and testing new models. Prerequisite: MATH 226 with a minimum grade of C or placement. Offered alternate years. 4 credits.

MATH-306 Linear Algebra

Systems of linear equations, vector spaces, dependence, basis, dimension, linear transformations, determinants, eigenvalues, eigenvectors, orthogonal matrices, curves of best fit, quadratic forms. Attention to computational, and graphical applications and argumentation. Prerequisite: MATH 226 and MATH 240 each with a minimum grade of C. 4 credits.

MATH-311 Ordinary Differential Equations

Topics include the theory of linear equations, investigations of non-linear equations, systems of equations, numerical methods, stability, long-term behavior and Laplace transforms. Emphasis is placed on both quantitative and qualitative descriptions of solutions and applications. Prerequisite: MATH 227 with a minimum grade of C. Offered alternate years 2014-2016. 4 credits.

MATH-316 Mathematical Probability and Statistics

This course covers the fundamentals of mathematical probability and statistics, including the axioms of probability, conditional probability, discrete and continuous random variables, multivariate distributions, moment generating functions, the binomial, geometric, Poisson, normal, and exponential distributions and the Central Limit Theorem. Additional topics from statistical inference theory such as order statistics, confidence intervals, and Chi-Square tests in addition to estimation of parameters using maximum likelihood methods will also be covered as time permits. Prerequisite: MATH 228 (may be taken concurrently) and MATH 240 each with a minimum grade of C. Alternate years. 4 credits.

MATH-321 Higher Geometry

A rigorous study of both Euclidean and non-Euclidean geometries. Prerequisite: MATH 240 with a minimum grade of C. Offered alternate years. 4 credits.

MATH-326 Introduction to Analysis

Provides a transition from calculus to real and complex analysis. Focuses on rigorous development of fundamental concepts in calculus including limits, convergence of sequences and series, compact sets, continuity, uniform continuity and differentiability of functions. Prerequisite: MATH 227 and MATH 240 each with a minimum grade of C. 4 credits.

MATH-355 Special Topics

Go to <https://www.pacificu.edu/about-us/centers-institutes/advising-center/new-topics-travel-class-descriptions> or see the Advising Center.

MATH-360 Special Topics in Mathematics

The topic of this course will change from year to year, and will depend on the interests and judgment of the math department faculty. Examples of topics may include the history of mathematics, dynamical systems, foundations and logic, mathematical biology, topology, graph theory, number theory, and differential geometry. Prerequisite: MATH 240 with a minimum grade of C; additional prerequisites may apply depending on the topic. May be repeated once for credit. 4 credits.

MATH-385 Junior Seminar

This course is designed to help students learn how to read mathematics, to communicate it through mathematical writing and speaking, and to prepare students for careers in mathematics and related fields. Students will read and present two journal articles. Contents will further include the mathematical writing package LaTeX and presentation software Beamer, as well as career planning and graduate school preparation. Students will also attend mathematical colloquia and mathematics projects presented during senior project day. Prerequisite: Junior standing or above (60 or more completed credits) and 6 credits of 300-level MATH courses with a minimum grade of C. 2 credits.

MATH-395 Independent Study

See department for details. Independent study contract required.

MATH-400 Number Theory

Studies the theory of numbers with an emphasis on algebraic structures. Topics may include modular arithmetic, quadratic fields, Pell's equations, quadratic reciprocity, sums of squares, unit groups, factorization in number rings, ideals, diophantine equations, and the geometry of numbers. Prerequisite: MATH 306 with a minimum grade of C. Offered alternate years. 4 credits.

MATH-402 Abstract Algebra

A survey of fundamental concepts in abstract algebra. Topics may include Group theory, including quotient groups, fundamental results on group homomorphisms and the study of finite groups; Ring theory, including fundamental homomorphism theorems, quotient rings and Euclidean rings, vector spaces and modules; Field theory including field extensions, Galois theory and classical results concerning constructability and solvability. Prerequisite: MATH 240 and MATH 306 each with a minimum grade of C. Offered alternate years. 4 credits.

MATH-405 Real Analysis

A rigorous treatment of the limit concept, continuity, differentiation and integration. Sequence and series convergence. Uniform and pointwise convergence of sequence and series of functions. Prerequisites: MATH 326 with a minimum grade of C. Offered alternate years. 4 credits.

MATH-410 Discrete Topics

This course will provide advanced study of a topic in discrete mathematics. Topics may include graph theory, combinatorics, discrete optimization, or set theory. Prerequisite: MATH 227 and MATH 240 with a minimum grade of C; other prerequisites as required by the topic. Offered alternate years. 4 credits.

MATH-411 Partial Differential Equations

Addresses solution methods for the three basic partial differential equations of mathematical physics: the heat, wave and potential equations. Methods covered will include power series, Fourier series, Laplace transform methods, separation of variables, and the method of characteristics. Initial and

boundary data will also be covered, as well as physical applications and numerical simulations of solutions. Special topics as time permits. Prerequisite: MATH 228 and MATH 311 each with a minimum grade of C. Offered alternate years. 4 credits.

MATH-412 Complex Analysis

Complex numbers, analytic functions, elementary functions, mapping by elementary functions, integrals, series, residues and poles, conformal mapping. Prerequisites: MATH 228 and MATH 240 both with a minimum grade of C. Offered alternate years. 4 credits.

MATH-455 Special Topics

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MATH-475 Internship

See department for details. Internship contract required.

MATH-490 Senior Capstone

Students will have the opportunity to use their mathematical skills and knowledge to investigate projects of their choice under the supervision of faculty in mathematics. The project will result in a final paper and senior capstone presentation. Prerequisite: Senior standing (90 or more completed credits), a declared Mathematics major, and 9 credits of upper division MATH courses with a minimum grade of C. 1 credit.

MATH-492 Senior Capstone II

This is a continuation of MATH 490. Prerequisite: MATH 490 with a minimum grade of C. 1 credit.

MATH-495 Independent Study

See department for details. Independent study contract required.