

KALAMAZOO COLLEGE
2017-2018 ACADEMIC CATALOG

Mathematics

Professors: Barth, Cutter, Intermont, Nordmoe (Chair), Oloo, West

The mission of the Mathematics Program is to foster in all our students critical habits of mind: description, analysis and interpretation. The Program is designed to prepare its majors for successful lifetime engagement with mathematics whether it be through applied work in industry or government; research in mathematics, statistics, or one of the other mathematical sciences; teaching; or applying mathematics in the physical, computing, or social sciences. For non-majors, the Program builds substantive skills in quantitative and abstract reasoning and in their application to the study of modern society.

Advanced Placement

For purposes of course placement and prerequisites, a score of 4 or 5 on the AB calculus exam (or an AB subscore of the BC calculus exam) is regarded as equivalent to successful completion of MATH 112. A score of 4 or 5 on the BC calculus exam is equivalent to MATH 113. A score of 4 or 5 on the statistics exam is equivalent to MATH 260.

Transfer, Dual Enrollment, Study Abroad Credit

Courses taken at other institutions will be awarded credit in mathematics if they meet one of the following criteria:

1. The course is similar in content and rigor to an existing course in the Mathematics department (and there are legitimate reasons why the student is not able to take the class at the College)
2. The course covers some important topic of mathematics not offered at Kalamazoo College. Students are responsible for meeting with the department chair in advance to determine whether a course offered elsewhere will transfer back as a mathematics credit.

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Requirements for the Major in Mathematics

Number of Units

Eight units of mathematics are required, exclusive of SIP and CS Cognate. Typically up to two units from outside courses (AP, transfer, dual enrollment, or study abroad) may count towards the major or minor in mathematics. MATH-260 and MATH-261 do not count for the major. Students who wish to apply additional external units toward the major must consult with the department.

Required Courses

MATH 112-113 Calculus I and II

MATH 214 Calculus III

MATH 240 Linear Algebra and Vectors

MATH 320 Real Analysis I or MATH 330 Abstract Algebra I

One two-term sequence beyond calculus (e.g., Real Analysis I and II, Abstract Algebra I and II, Probability and Mathematical Statistics, Abstract Algebra I and Linear Algebra II)

Required Cognate

One computer science course.

Among the courses we offer, MATH 320 and MATH 330 are at the highest level of abstraction. Before enrolling in one of these courses, students are strongly encouraged to complete MATH 314, MATH 316 or MATH318.

For students interested in graduate work in one of the mathematical sciences, additional work in MATH 280, 310, 314, 316, 320, 330, 420, 430, and 450 is appropriate. Those with a strong interest in computing should elect the minor in computer science in addition to MATH 300. For those students interested in applied work (mathematical biology, mathematical economics, operations research, etc.), election of MATH 270, 280, 310, 362, 365, 440, and at least two courses in computer science is appropriate. Other departments offer classes that use mathematical ideas: BIOL 112, 426, and 436; CHEM 310 and 410; ECON 305 and 412; PHIL 107; PHYS 340, 400, 410, and 420; and PSYC 390.

Mathematics Colloquium Credit

In addition to the requirements stated above, mathematics majors are required to complete the Mathematics Colloquium requirement. See the mathematics department for details.

Comprehensive Exams

Mathematics majors are required to satisfactorily complete the Sophomore Comprehensive exam and the Senior Comprehensive Exam.

Requirements for the Minor in Mathematics

There are four options for the minor in mathematics, each of which requires six units of credit in mathematics. Each of these options requires the "core" courses: Single variable calculus (MATH 112 and MATH 113), Multivariable Calculus (MATH 214), and Linear Algebra (MATH 240). The other required courses for each option are as follows:

Statistics Option

MATH 362 Probability

MATH 365 Mathematical Statistics

Computational Mathematics Option

MATH 250 Discrete Mathematics or MATH 330 Abstract Algebra I

MATH 300 Automata, Formal Languages, and Computability

Applied Mathematics Option

MATH 280 Differential Equations

MATH 310 Complex and Vector Variables

Pure Mathematics Option

MATH 320 Real Analysis I or MATH 330 Abstract Algebra I

And one other mathematics course from the following list:

MATH 310, MATH 314, MATH 316, MATH 320, MATH 330, MATH 362, or any 400-level course

****Note: MATH-260 and MATH-261 do not count for the minor****

Study Abroad

Students interested in mathematics are especially encouraged to consider the study abroad program in Budapest. The Budapest program is given in English; no prior knowledge of Hungarian is needed. It offers a number of mathematics courses as well as history, language, and literature courses. Mathematics majors have also studied mathematics in Erlangen, Quito, Perth, Aberdeen, and Lancaster. Early consultation with the department is strongly urged.

Mathematics courses

MATH 105 Quantitative Reasoning and Statistical Analysis

An introduction to some of the quantitative techniques used to clarify ordinary experience and to some of the statistical ideas used to shape public policy and human sciences, with emphasis on the concepts involved in producing, organizing, and drawing conclusions from data. Does not count toward the major or minor. Not open to students who already have credit from ANSO-212, MATH-260, or MATH-261.

MATH 110 Calculus I with Review, Part 1

MATH 110 and 111 cover in two terms the material covered in Mathematics 112. In addition, topics from precalculus mathematics are reviewed and practiced as needed. Precalculus topics include: algebra and analytic geometry; linear, quadratic, polynomial and rational functions; and trigonometric functions. Enrollment is restricted to those who were advised to take Math 110-111 on the basis of the department's placement examination. The two-term Math 110-111 sequence serves as an alternate prerequisite for all college courses requiring MATH 112.

MATH 111 Calculus I with Review, Part 2

This course continues the study of calculus begun in MATH 110. Review of precalculus mathematics continues as needed.
Prerequisite: Take MATH-110 All course prerequisites must be met with a minimum grade of C-.

MATH 112 Calculus I

Differential calculus of single-variable functions: limits, derivatives, differentiation rules, related rates, optimization. An emphasis on problem solving using the tools of differential calculus with application to the natural and social sciences.
Prerequisite: Math Placement Exam Required

MATH 113 Calculus II

Integral calculus of single-variable functions: the fundamental theorem of calculus, techniques of integration, infinite sequences and series. An emphasis on problem solving using the tools of integral calculus with application to the natural and social sciences.
Prerequisite: MATH-112 All course prerequisites must be met with a minimum grade of C-.

MATH 214 Calculus III

Series, vectors in two and three dimensions, and integral and differential calculus of functions of several variables.
Prerequisite: MATH-113 All course prerequisites must be met with a minimum grade of C-.

MATH 240 Linear Algebra and Vectors

Study of vector spaces, matrices, determinants, linear transformations, systems of equations and eigenvalues.
Prerequisite: MATH-113 All course prerequisites must be met with a minimum grade of C-.

MATH 250 Discrete Mathematics

Introduction to formal structures and mathematical reasoning. Graphs, sets, logic, induction, structure of mathematical proof, counting, relations, and algebraic structures.
Prerequisite: MATH-112 and one computer science course. All course prerequisites must be met with a minimum grade of C-.

MATH 260 Applied Statistics I

Introduction to statistics including methods of data collection and description, correlation and regression, chance, and statistical inference. The course makes extensive use of technology and is designed for students in the behavioral, biological, and social sciences. Does not count towards the major or minor in mathematics. Not open to students who already have credit from MATH-261
Prerequisite: Not open to students who already have credit from MATH-261

MATH 261 Biostatistics

Introduction to statistics with particular attention to applications in biology and health sciences. Topics include sampling methods, design of experiments, exploratory data analysis, estimation, tests of significance, ANOVA, and correlation and regression analysis. BIOL 112 and 123 highly recommended. Does not count towards the major or minor in mathematics. Not open to students who already have credit from MATH-260
Prerequisite: Not open to students who already have credit from MATH-260

MATH/PHYS 270 Nonlinear Dynamics and Chaos

Dynamical systems are mathematical objects used to model phenomena of natural and social phenomena whose state changes over time. Nonlinear dynamical systems are able to show complicated temporal, spatial, and spatiotemporal behavior. They include oscillatory and chaotic behaviors and spatial structures including fractals. Students will learn the basic mathematical concepts and methods used to describe dynamical systems. Applications will cover many scientific disciplines, including physics, chemistry, biology, economics, and other social sciences. Appropriate for Math or Physics Majors. Either MATH 305 or this course, but not both, may be counted towards the major in mathematics.

MATH 280 Differential Equations and Numerical Methods

Introduction to key concepts underlying analytical methods for the solution of ordinary differential equations and first-order systems studied together with techniques for constructing approximate numerical solutions.

Prerequisite: MATH-214 and MATH-240 All course prerequisites must be met with a minimum grade of C-.

MATH/COMP 300 Automata, Formal Languages, and Computability

Study of automata as mathematical models of computation; of formal languages, which play a central role in the specification and translation of programming languages; and of the fundamental capabilities and limitations of computers.

Prerequisite: MATH-250 or MATH-330, and 1 COMP course All course prerequisites must be met with a minimum grade of C-.

MATH/IDSY 305/PHYS 482 Dynamic Models in Social Science

The study of why mathematical and computational methods are important in understanding social phenomena, and how different social phenomena can be described by proper mathematical models. Specifically, applications of the theory of dynamical systems will be presented. Designed for math/science and social science students. Either MATH/PHYS 270 or this course, but not both, may be counted towards the major in mathematics.

Prerequisite: MATH-113 All course prerequisites must be met with a minimum grade of C-.

MATH 310 Complex and Vector Variables

Generalizations of differentiation and integration to spaces of higher dimension: divergence, curl, and the classical integration theorems of multivariable calculus. Introduction to analytic functions of a complex variable, including Laurent series, Cauchy's formula, and conformal mapping.

Prerequisite: MATH-214 and MATH-240 All course prerequisites must be met with a minimum grade of C-.

MATH 316 Topics in Number Theory

Study of classical number theory including distribution of primes, congruences, the Euler Phi function, and quadratic reciprocity. This course will also focus on developing proof writing skills. Prerequisite: MATH 214 and MATH 240

MATH 318 Topics in Topology

An introduction to topological spaces including the study of connectedness, metric spaces, and compactness. This course will also focus on developing proof writing skills.

Prerequisite: MATH-214 MATH-240; All course prerequisites must be met with a minimum grade of C-.

MATH 320 Real Analysis I

Introduction to basic topological concepts in metric spaces followed by rigorous development of classical real analysis including sequences and series of functions, continuity, differentiability, and Riemann-Stieltjes integration. This course is among the most theoretical in our curriculum. Before enrolling, students are strongly encouraged to complete MATH 250, MATH 310, MATH 314, or MATH 318.

Prerequisite: MATH-214 and MATH-240 All course prerequisites must be met with a minimum grade of C-.

MATH 330 Abstract Algebra I

Study of modern abstract algebra including groups, rings, fields, and other algebraic structures together with advanced topics of linear algebra. This course is among the most theoretical in our curriculum. Before enrolling, students are strongly encouraged to complete MATH 250, MATH 310, MATH 314, or MATH 318.

Prerequisite: MATH-214 and MATH-240 All course prerequisites must be met with a minimum grade of C-.

MATH 360 Applied Statistics II

This course uses real data case studies to review descriptive statistics and to explore statistical inference for means, proportions, and transformations; analysis of variance; and regression. Statistical software is used throughout. The course is recommended both for students planning to do graduate coursework in the behavioral, biological, and social sciences and for mathematics majors seeking a comprehensive introduction to statistical methods.

Prerequisite: 200-level math course. All course prerequisites must be met with a minimum grade of C-.

MATH 362 Probability

Study of mathematical theory of probability. Topics include data analysis, discrete and continuous sample spaces, combinatorial problems, random variables, probability densities and distributions, expected value, moment-generating functions, functions of a random variable, sampling distributions, and the central limit theorem.

Prerequisite: MATH-113 All course prerequisites must be met with a minimum grade of C-.

MATH 365 Mathematical Statistics

Study of statistical inference. Topics include sampling theory, point and interval estimations, hypothesis testing, and regression. Stochastic processes, analysis of variance, simple experimental design, and nonparametric statistics may also be included.

Prerequisite: MATH-362 All course prerequisites must be met with a minimum grade of C-.

MATH 420 Real Analysis II

Continuation of MATH 320. .

Prerequisite: MATH-320 All course prerequisites must be met with a minimum grade of C-.

MATH 430 Abstract Algebra II

Continuation of MATH 330.

Prerequisite: MATH-330 All course prerequisites must be met with a minimum grade of C-.

MATH 440 Linear Algebra II

Treatment of topics such as linear equations, orthogonal projections and least squares, pseudoinverses, eigenvalues and eigenvectors, diagonalization, canonical forms of linear transformations, positive definite matrices, the norm of a matrix, linear programming, and game theory.

Prerequisite: MATH-240 All course prerequisites must be met with a minimum grade of C-.

MATH 450 Topics in Pure and Applied Mathematics

Readings in pure and applied mathematics. Content varies from year to year. Possible topics include: set theory, number theory, geometry, topology.

Prerequisite: 1 COMP course and MATH-250 or MATH-316 or MATH-330 All course prerequisites must be met with a minimum grade of C-.

MATH 490 Senior Seminar

In this course we will explore some of the meta-themes of mathematics. In particular, we will examine how themes such as continuity and approximation are evident - or not - in various branches of mathematics. We will also reflect on such topics as the role of proof in mathematics versus the role of intuition, and what literacy in mathematics means.

MATH 593 Senior Individualized Project

Each program or department sets its own requirements for Senior Individualized Projects done in that department, including the range of acceptable projects, the required background of students doing projects, the format of the SIP, and the expected scope and depth of projects. See the Kalamazoo Curriculum -> Senior Individualized Project section of the Academic Catalog for more details.

Prerequisite: Permission of department and SIP supervisor required.

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