

MATHEMATICS

Mathematics is the study of patterns, both quantitative and spatial. As such, it is the key to understanding our natural and technical world. Through the study of mathematics, students develop skills in problem solving, critical thinking and clear, concise writing.

ABOUT THE PROGRAM

The Department of Mathematics offers courses which serve as a fundamental part of a liberal education and as a basis for work in other disciplines. In addition, the department offers a complete major program providing opportunities for a deeper study of mathematics. Mathematics majors pursue a wide range of career options, including work in teaching, business, industry and government service. Many mathematics majors choose to continue their studies with graduate work in mathematics, statistics, computer science or other fields which require significant mathematical background, such as economics or science.

The department also provides opportunities for independent study and research. Collaborative student/faculty research projects have been conducted in the areas of mathematical modeling, chaos theory, dynamical systems, statistics, real analysis, complex analysis, linear algebra, algebra, representation theory, geometry and bioinformatics.

Study abroad opportunities are available in Budapest, Hungary and Aberdeen, Scotland. In addition, majors can study off-campus at a variety of domestic locations such as Oak Ridge National Laboratory.

MAJORS

The Department of Mathematics offers both a Bachelor of Science and a Bachelor of Arts in mathematics. Many of our majors are double majors or minors in areas such as chemistry, physics, computer science and economics. We also have majors who have a second major or minor in areas such as music and English. About half of our mathematics majors become teachers. We offer a Mathematics Secondary Education Major for students intending to become middle school or high school mathematics teachers. We also offer a Mathematics Elementary Education Major for students going into elementary or middle school teaching.

Bachelor of Arts Degree

The requirement for a Bachelor of Arts degree in mathematics is a plan of study designed in consultation with a departmental advisor, and includes a total of at least 34 credits in mathematics as follows:

- MA 280, 331 and 341 must be included

- Additional credits chosen from the following courses: MA 126, 131, 132, 231, 232, and all courses numbered above 300 *except* 323 and 324
- No more than 16 credits from courses numbered 232 and lower shall be counted towards the 34 required credits

See individual course descriptions for prerequisites.

Bachelor of Science Degree

The requirement for a Bachelor of Science degree in mathematics is a plan of study designed in consultation with a departmental advisor, and includes a total of 60 credits of courses from the natural science division of which at least 39 credits must be in mathematics as follows:

- MA 280, 331 and 341 must be included
- Additional credits chosen from the following courses: MA 126, 131, 132, 231, 232, and all courses numbered above 300 *except* 323 and 324
- No more than 16 credits from courses numbered 232 and lower shall be counted towards the 39 required credits

See individual course descriptions for prerequisites.

Mathematics Elementary Education

In partnership with the Hope College Department of Education, the Department of Mathematics offers a teaching major in the elementary level for certification through the State of Michigan.

The requirement for a major in mathematics with elementary teaching emphasis is a plan for study designed in consultation with a departmental advisor, and includes a total of at least 34 credits in mathematics as follows:

- Complete MA 126 or MA 131
- Complete MA 132, 205, 206, 231, 280, 311, 312, 321 and 351
- Complete at least 4 additional credits selected from MA 207, MA 208, and GEMS courses centered on mathematical topics (GEMS 100 or 105).

Mathematics Secondary Education

In partnership with the Hope College Department of Education, the Department of Mathematics offers a teaching major in the secondary level for certification through the State of Michigan.

The requirement for a Bachelor of Arts degree in mathematics for those intending to become middle school or high school mathematics teachers is a plan of study designed in consultation with a departmental advisor, and includes a total of at least 34 credits in mathematics as follows:

- MA 132, 231, 280, 311, 312, 321, 331, 341, and 351 must be included
- Additional credits chosen from the following courses: MA 126 or 131, MA 232 and all courses numbered above 300 *except* 323 and 324
- No more than 16 credits from courses numbered 232 and lower shall be counted towards the 34 required credits
- MA 323 and 324 must also be taken (*this counts as education credit, and does not count toward the 34 mathematics credits*).

MINORS

The Department of Mathematics offers both a Bachelor of Science and a Bachelor of Arts in mathematics. Many of our majors are double majors or minors in areas such as chemistry, physics, computer science, and economics. We also have majors who have a second major or minor in areas such as music and English. We offer a Mathematics Secondary Education Minor for students intending to become middle school or high school mathematics teachers. We also offer a Mathematics Elementary Education Minor for students going into elementary teaching.

Mathematics

A minor in mathematics consists of at least 19 credits from the following courses: MA 126, 131, 132, 231, 232, 280, and all courses numbered above 300 except 323 and 324. No more than 16 credits from courses numbered 232 and lower shall be counted towards the 19 required credits.

Note: For students desiring an applied focus to their minor (e.g., actuarial studies, statistics, mathematical biology, mathematical modeling, etc.) recommended courses include courses in:

- Calculus (MA 126, 131, 132, 231, 232)
- Statistics (MA 311/312)
- Probability (MA 361)
- Linear Algebra (MA 345)
- Differential Equations (MA 370)
- Numerical Analysis (MA 372)

For more specific recommendations for your proposed career, speak with your advisor or a member of the Department of Mathematics.

Mathematics Elementary Education

In partnership with the Hope College Department of Education, the Department of Mathematics offers a teaching minor at the elementary level for certification through the State of Michigan.

The requirement for a minor in mathematics with elementary teaching emphasis is a plan of study designed in consultation with a departmental advisor, and includes a total of at least 22 credits in mathematics as follows:

- Complete two courses from MA 123, 125, 126, 131, 132 for a total of 8 credits
- Complete MA 205 and 206
- Complete either MA 210, MA 311 and 312, or MA 311 and MA 0110 – Statistics transfer credit
- Complete at least 4 additional credits selected from MA 207, MA 208, and GEMS courses centered on mathematical topics (GEMS 100 or 105).

Mathematics Secondary Education

In partnership with the Hope College Department of Education, the Department of Mathematics offers a teaching minor in the secondary level for certification through the State of Michigan.

The requirement for a minor in mathematics for those intending to become middle school or high school mathematics teachers is a plan of study designed in consultation with a departmental advisor, and includes a total of at least 24 credits in mathematics as follows:

- MA 132, 231, 280, 311, 312, 321, and 351 must be included
- Additional credits chosen from the following courses: MA 126 or 131, MA 232, and all courses numbered above 300 *except* 323 and 324
- No more than 16 credits from courses numbered 232 and lower shall be counted towards the 24 required credits
- MA 323 and 324 must also be taken (*this counts as education credit and does not count toward the 24 mathematics credits*)

Note: a student cannot receive credit for both MA 123 and MA 125, or MA 126 and MA 131.

COURSES

MATHEMATICS

MATH 123 - A Study of Functions

A study of functions including polynomial, rational, exponential, logarithmic, and trigonometric functions. These will be explored in their symbolic, numerical, and graphic representations, and connections between each of these representations will be made. A graphing calculator is required. Cannot receive credit for both Math 123 and Math 125.

Credits Awarded: 4

Terms Offered: Spring

Attribute: Mathematics II (MA2)

MATH 125 - Calculus with Review I

This course covers the material typically taught in the first half of a Calculus I course. The calculus material is supplemented by reviewing topics of high school mathematics as needed. The calculus topics are also taught at a slower pace. Topics include function review, limits and continuity, the concept (and definition) of a derivative, and differentiation rules (product rule, quotient rule, chain rule are included). Cannot receive credit for both Math 125 and Math 123.

Credits Awarded: 4

Terms Offered: Fall

Attribute: Mathematics II (MA2)

MATH 126 - Calculus with Review II

This course is a continuation of Math 125. The topics covered are the topics typically taught in the second half of a Calculus I course. The calculus material in the course is supplemented by reviewing topics of high school mathematics as needed. The calculus topics are also taught at a slower pace. Topics include implicit differentiation, applications of differentiation, L'Hospital's rule, Newton's method, the integral, and applications of integration. Cannot receive credit for both Math 126 and Math 131.

Credits Awarded: 4

Terms Offered: Spring

Prerequisites: Math 125 with grade of C- or better

Attribute: Mathematics II (MA2)

MATH 131 - Calculus I

Topics include functions, limits, continuity, differentiation, integration, and applications of the derivative and integral. Cannot receive credit for both Math 131 and Math 126. ACT Math score of 25+ is highly recommended.

Credits Awarded: 4

Terms Offered: Fall, Spring

Attribute: Mathematics II (MA2)

MATH 132 - Calculus II

Topics covered include techniques of integration, applications of the integration, sequences, infinite series, power series, introduction to differential equations, and polar coordinates.

Credits Awarded: 4

Terms Offered: Fall, Spring

Prerequisites: Math 126 or Math 131 with a grade of C- or better

Attribute: Mathematics II (MA2)

MATH 205 - Mathematics for Elementary and Middle School Teachers I

The first of a two-course sequence in which prospective K-8 teachers explore the fundamental aspects of the mathematics they will be expected to teach in their future classrooms. Emphasis is on developing a conceptual understanding of the mathematics and the ability to communicate mathematical concepts effectively to K-8 students. Topics addressed: Number Concepts and Operations; Algebraic Thinking, Statistics & Probability. Proficiency in basic mathematical skills is assumed. For prospective elementary and middle school teachers only. Completion of, or concurrent enrollment in, an Educ 200-level course is highly recommended prior to this course.

Credits Awarded: 4

Terms Offered: Fall

Prerequisites: Educ 220 and Educ 221

Attribute: Mathematics II (MA2)

MATH 206 - Mathematics for Elementary and Middle School Teachers II

A continuation of Math 205 with a focus on geometry and measurement. For prospective elementary and middle school teachers only.

Credits Awarded: 2

Terms Offered: Spring

Prerequisites: Math 205 with a grade of C- or better

Attribute: Mathematics II (MA2)

MATH 207 - K-8 Mathematics Software Applications

A course designed to deepen participants' understanding of mathematical concepts by exploring current information and communication technologies used in K-8 classrooms. As technology rapidly changes, emphasis is on "learning to learn" with different technologies in a project-focused, collaborative setting.

Credits Awarded: 2

Terms Offered: Spring, Odd Years

Prerequisites: Math 205 with a grade of C- or better

MATH 208 - Problem Solving for Elementary and Middle School Teachers

A course designed to integrate content areas of mathematics with the practice of problem solving. Emphasis will be given to group work, oral presentation and multiple solution methods. For prospective elementary and middle school teachers only.

Credits Awarded: 2

Terms Offered: Spring, Even Years

Prerequisites: Math 205 with a grade of C- or better

MATH 210 - Introductory Statistics

The course begins by exploring statistical inference for one and two variables using a randomization approach, while reviewing basic descriptive statistical techniques. The course then explores the relationship between randomization methods and traditional inference techniques, estimation using confidence intervals and statistical power and its impact on sample design decisions. Throughout the course there is an emphasis on active-learning using group activities and projects, as well as reading and critiquing research from mainstream and peer-reviewed media sources. Activities, projects and hands-on learning activities are conducted using a variety of approaches but make heavy use of the computer and statistical software. Cannot receive credit for both Math 210 and Math 311.

Credits Awarded: 4
 Terms Offered: Fall, Spring
 Attribute: Mathematics II (MA2)

MATH 231 - Multivariable Mathematics I

The study of linear algebra and ordinary differential equations.

Credits Awarded: 4
 Terms Offered: Fall, Spring
 Prerequisites: Math 132 with a grade of C- or better
 Attribute: Mathematics II (MA2)

MATH 232 - Multivariable Mathematics II

The study of systems of differential equations and multivariable calculus including differentiation, multiple integration, and calculus on vector fields.

Credits Awarded: 4
 Terms Offered: Fall, Spring
 Prerequisites: Math 231 with a grade of C- or better
 Attribute: Mathematics II (MA2)

MATH 280 - Bridge to Higher Mathematics: An Introduction to Mathematical Proof

An introduction to the understanding and creation of rigorous mathematical argument and proof. Topics include properties of the integers, real numbers, and integers modulo n . Additional topics may include mathematical induction, elementary set theory, elementary number theory, recursion formulas, counting techniques, equivalence relations, partitions and cardinality of sets. There will be a heavy emphasis on writing, in particular the writing of mathematical arguments and proofs.

Credits Awarded: 3
 Terms Offered: Spring
 Prerequisites: Math 132

MATH 295 - Studies in Mathematics

A course offered in response to student interest and need. Covers mathematical topics not included in regular courses.

Credits Awarded: 1-3
 Terms Offered: Fall, Spring
 Prerequisites: Permission of instructor

MATH 311 - Statistical Methods

This course has the same content and learning objectives as Math 210 but the material is covered in half the time. The course is designed for students who have a significant prior experience with statistics (e.g., high school statistics course) or calculus. Read the Math 210 course description for course content details. Cannot receive credit for both Math 210 and Math 311.

Credits Awarded: 2
 Terms Offered: Spring
 Prerequisites: Math 131
 Attribute: Mathematics II (MA2)

MATH 312 - Applied Statistical Models

This course provides a survey of statistical methods students would expect to see utilized across disciplines in peer reviewed research. As such, the course focuses on the design and analysis of studies where the research questions involve more than two variables simultaneously. Topics include multiple and non-linear regression, non-parametric methods, general linear models, and multivariate statistical models. The pedagogical approach is similar to that of Math 210 and Math 311.

Credits Awarded: 2

Terms Offered: Spring

Prerequisites: Math 210 or Math 311

Attribute: Mathematics II (MA2)

MATH 318 - Mathematical Biology

An exploration of the ways in which mathematics is used to understand and model biological systems. Using examples from ecology, neuroscience, epidemiology, and molecular evolution, we will focus on continuous and discrete models and their analytical and computational solutions. Systems of differential equations, linear algebra, and statistical methods will figure prominently among the mathematical topics. Students will become familiar with the statistical, graphical & modeling capabilities of the R computer language. Cross-listed with Biol 318.

Credits Awarded: 4

Terms Offered: Spring, Odd years

MATH 321 - History of Mathematics

This course is designed to give mathematics students an opportunity to study the various periods of mathematical development. Attention will be given to the early Egyptian-Babylonian period, the geometry of Greek mathematicians, the Hindu and Arabian contribution, the evolution of analytical geometry since Descartes, the development of calculus by Newton and Leibniz, and non-Euclidean geometry. Some attention will be given to the methods and symbolisms used in problem solving during various periods of time.

Credits Awarded: 2

Terms Offered: Fall

Prerequisites: Math 132

MATH 323 - Teaching of Mathematics in the Secondary School

Methods of teaching mathematics with emphasis on varied approaches, classroom materials, curriculum changes, and trends in mathematics education. Cross-listed as Educ 323.

Credits Awarded: 2

Terms Offered: Fall

Prerequisites: Declared education major

Corequisites: Math 324

MATH 324 - Teaching Mathematics in the Secondary School Field Placement

This is a field placement that must be taken concurrently with Math 323.

Credit Awarded: 1

Terms Offered: Fall

Prerequisites: Declared education major

Corequisites: Math 323

MATH 331 - Real Analysis I

Study of the real number system, sequences, functions, continuity, uniform continuity, differentiation, and theory of integration.

Credits Awarded: 3

Terms Offered: Fall

Prerequisites: Math 232, Math 280

MATH 332 - Real Analysis II

A continuation of Math 331 including functions of several variables, series, uniform convergence, Fourier Series.

Credits Awarded: 3

Terms Offered: Spring, Even Years

Prerequisites: Math 331

MATH 334 - Complex Analysis

The study of the algebra and geometry of complex numbers, analytic functions, complex integration, series, conformal mapping.

Credits Awarded: 3

Terms Offered: Fall, Odd Years

Prerequisites: Math 232

MATH 341 - Algebraic Structures I

An introduction to algebraic systems including a study of groups, rings, and integral domains.

Credits Awarded: 3

Terms Offered: Fall

Prerequisites: Math 232, Math 280

MATH 342 - Algebraic Structures II

A continuation of Math 341 including topics chosen from Galois theory, advanced linear algebra, group representation theory, and algebraic geometry.

Credits Awarded: 3

Terms Offered: Spring, Odd Years

Prerequisites: Math 341

MATH 345 - Linear Algebra

The study of abstract vector spaces, matrices and linear transformations, determinants, canonical forms, the Hamilton-Cayley theorem, inner product spaces.

Credits Awarded: 3

Terms Offered: Spring, Even Years

Prerequisites: Math 231, Math 280

MATH 351 - College Geometry

A modern approach to geometry for students with some background in calculus and an interest in secondary teaching. Attention is given to the role of axioms in elementary geometry and in the development of other geometries.

Credits Awarded: 3

Terms Offered: Fall

Prerequisites: Math 280

MATH 360 - Combinatorics and Graph Theory

A study of topics in discrete mathematics. Topics may include enumeration, algorithms, graph theory, graph planarity, graph coloring, the pigeonhole principle, permutations and combinations, binomial coefficients, search algorithms, generating functions, and recurrence relations.

Credits Awarded: 3

Terms Offered: Spring, Odd Years

Prerequisites: Math 280

MATH 361 - Introduction to Probability

This course provides an introduction to both discrete and continuous probability. Topics include conditional probabilities and independence, combinations and permutations, Bayes' theorem, popular discrete and continuous distributions (e.g., binomial, normal, Poisson, exponential), bivariate and multivariate distributions, covariance and correlation, moment generating functions and limit theorems. In addition to serving as preparation for the first actuarial exam, this course also serves as a general introduction to probability for all students interested in applied mathematics.

Credits Awarded: 3
 Terms Offered: Fall, Even Years
 Prerequisites: Math 132
 Corequisites: Math 363

MATH 362 - Mathematical Statistics

Emphasis on inferential statistics. Estimation, confidence intervals, testing of statistical hypotheses, regression and correlation, analysis of variance, control charts, non-parametric methods.

Credits Awarded: 3
 Terms Offered: As Needed
 Prerequisites: Math 361
 Corequisites: Math 364

MATH 363 - Probability Problem Solving Session

This course runs concurrent to Math 361 and serves as an opportunity to practice probability problems. This course is required for all students in Math 361.

Credit Awarded: 1
 Terms Offered: Fall, Even Years
 Prerequisites: Math 132
 Corequisites: Math 361

MATH 364 - Laboratory for Mathematical Statistics

A computer-based laboratory to aid the learning and understanding of statistical concepts in Math 362.

Credit Awarded: 1
 Terms Offered: As needed
 Prerequisites: Math 361
 Corequisites: Math 362

MATH 370 - Advanced Differential Equations

Advanced topics in ordinary differential equations including series solutions and orthonormal sets of solutions. Introduction to partial differential equations including the heat equation, the wave equation and the potential equation. Boundary value problems and Fourier Series will also be covered.

Credits Awarded: 3
 Terms Offered: Spring, Odd Years
 Prerequisites: Math 232

MATH 372 - Numerical Analysis

Topics may include the study of the source and analysis of computational error, finding the solution of an equation, systems of linear equations, interpolation and approximation, numerical integration and numerical solutions to differential equations.

Credits Awarded: 3
 Terms Offered: Spring, Even Years
 Prerequisites: Math 232

MATH 395 - Special Studies in Mathematics

A course offered in response to student and instructor interest. Topics are not generally covered in the regular course listings. Course may be taken multiple times if topics are different.

Credits Awarded: 1-4
 Terms Offered: As Needed

MATH 399 - Mathematics Seminar

A course for senior mathematics majors which includes problem solving, student presentations on mathematical topics, mathematical modelling, and discussions on the history and philosophy of mathematics. Attendance at department colloquia also required.

Credits Awarded: 2
Terms Offered: As Needed

MATH 434 - Elementary Topology

A systematic survey of the standard topics of general topology with emphasis on the space of real numbers. Includes set theory, topological spaces, metric spaces, compactness, connectedness, and product spaces. Students may take Math 331 either prior to enrollment in or concurrently with the class.

Credits Awarded: 3
Terms Offered: As Needed
Prerequisites: Math 331
Corequisites: Math 331

MATH 490 - Research in Mathematics

Course provides opportunity for a junior or senior mathematics major to engage in a research project in an area of mathematics in which the student has special interest.

Credits Awarded: 0-4
Terms Offered: Fall, Spring
Prerequisites: Permission of chairperson

MATH 493 - Independent Study in Mathematics

Course provides opportunity for a junior or senior mathematics major to engage in an independent study project in an area of mathematics in which the student has special interest.

Credits Awarded: 1-4
Terms Offered: Fall, Spring
Prerequisites: Permission of instructor

MATH 495 - Advanced Studies in Mathematics

Offered as needed to cover topics not usually included in the other mathematics courses. A student may enroll for either or both semesters.

Credits Awarded: 1-3
Terms Offered: Fall, Spring
Prerequisites: Permission of chairperson

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B.A., Moscow State University, 1991

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