

# MATHEMATICS (MATH)

## MATH 101 Review in Mathematics 1 Credit

Review of mathematical concepts and computations. Content will vary, but topics will be chosen in each case to prepare students for a specific subsequent course.

**Terms Typically Offered:** Fall.

## MATH 105 Elements of Mathematics I 3 Credits

Mathematics for the prospective elementary teacher with an emphasis on mathematical reasoning and processes. Topics include problem solving, set theory, number theory, numeration systems, the integers, and rational numbers.

**Prerequisites:** Appropriate placement test score and a planned major in elementary education or early childhood special education.

**Terms Typically Offered:** Fall, Spring.

## MATH 107 Career Math 3 Credits

Covers material designed for career technical or general studies students who need to study particular mathematical topics. Topics include measurement, algebra, geometry, trigonometry, graphs, and/or finance. These are presented on an introductory level and the emphasis is on applications.

## MATH 108 Technical Mathematics 4 Credits

Covers material designed for career technical or general studies students who need to study particular mathematical topics. Topics may include measurement, algebra, geometry, trigonometry, graphs, and/or finance. These are presented on an introductory level and the emphasis is on applications.

## MATH 110 Mathematical Investigations-GTMA1 3 Credits

Investigations into mathematical concepts approached through the lens of real-world applications and projects. Specific content includes problem solving, mathematical models, financial mathematics, set theory, logic, probability, descriptive statistics, and the appropriate use of technology.

**Prerequisites:** MATC 090 or equivalent or appropriate mathematics placement test score.

**Essential Learning Categories:** Mathematics See the program requirements list to determine the minimum level math needed  
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**Terms Typically Offered:** Fall, Spring, Summer.

## MATH 113 College Algebra-GTMA1 4 Credits

Approach to algebra with an emphasis on functions, modeling, and applications. Topics include properties and graphs of linear, polynomial, rational, exponential, logarithmic, and inverse functions; solving equations, inequalities and systems of linear equations; interpreting data and graphs. Technology tools will be utilized in addition to analytical methods.

**Prerequisites:** MATC 092 or equivalent, or appropriate mathematics placement test score.

**Equivalent Course(s):** MATH 113R

**Essential Learning Categories:** Mathematics See the program requirements list to determine the minimum level math needed  
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**Terms Typically Offered:** Fall, Spring, Summer.

## MATH 113R College Algebra with Review-GTMA1 5 Credits

Approach to algebra with an emphasis on functions, modeling, and applications. Topics include properties and graphs of linear, polynomial, rational, exponential, logarithmic, and inverse functions; solving equations, inequalities and systems of linear equations; interpreting data and graphs. Technology tools will be utilized in addition to analytical methods. Review and practice of necessary skills and concepts will be incorporated throughout.

**Prerequisites:** Appropriate mathematics placement test score and GPA, or MATC 092.

**Equivalent Course(s):** MATH 113

**Essential Learning Categories:** Mathematics See the program requirements list to determine the minimum level math needed

**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**Terms Typically Offered:** Fall, Spring.

## MATH 119 Precalculus Mathematics-GTMA1 5 Credits

In-depth treatment of the mathematics essential to Calculus. Topics include linear, polynomial, rational, exponential, logarithmic, inverse, and trigonometric functions.

**Prerequisites:** Appropriate mathematics placement test score.

**Essential Learning Categories:** Mathematics See the program requirements list to determine the minimum level math needed  
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**Terms Typically Offered:** Fall, Spring, Summer.

## MATH 119A Algebra for Calculus-GTMA1 4 Credits

In-depth treatment of the algebra essential to Calculus. Topics include the algebraic and graphical properties of linear, polynomial, rational, exponential, logarithmic, and inverse functions. This course is the first course in a two-semester sequence (MATH 119A/MATH 119B) equivalent to MATH 119.

**Prerequisites:** Appropriate mathematics placement test score.

**Essential Learning Categories:** Mathematics See the program requirements list to determine the minimum level math needed  
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**Terms Typically Offered:** Fall, Spring, Summer.

## MATH 119B Trigonometry for Calculus-GTMA1 3 Credits

In-depth treatment of the trigonometry essential to Calculus, incorporating a selection of algebraic concepts. This is the second course in a two-semester sequence (MATH 119A/MATH 119B) equivalent to MATH 119.

**Prerequisites:** MATH 119A.

**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**Terms Typically Offered:** Fall, Spring, Summer.

## MATH 121 Calculus for Business 3 Credits

Introduction to calculus with an emphasis on applications to business and economics. Topics include linear and quadratic functions, limits, continuity, differentiation, integration, the logarithmic and exponential functions, and applications.

**Prerequisites:** MATH 113 or appropriate placement test score.

**Terms Typically Offered:** Fall.

**MATH 130 Trigonometry 3 Credits**

College-level treatment of trigonometry. Topics include the Cartesian plane, functions, inverse functions, the circular function, trigonometric functions, graphs of trigonometric functions, trigonometric identities, solving trigonometric equations, inverse trigonometric functions, triangle solution techniques, and vectors.

**Prerequisites:** MATH 113 or appropriate mathematics placement test score.

**Terms Typically Offered:** Fall, Spring.

**MATH 131 Applied Calculus-GTMA1 4 Credits**

Introduction to fundamental concepts and techniques of calculus with an emphasis on modeling and applications. Topics include algebraic, periodic, exponential, and logarithmic functions and their graphs; notions of limits, continuity, rates of change, and accumulated change; differentiation; and integration.

**Prerequisites:** MATH 113 or appropriate placement test score.

**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**Terms Typically Offered:** Spring.

**MATH 135 Engineering Calculus I 4 Credits**

Introduction to differentiation and integration of functions of a single variable. Emphasis on computational aspects. Includes functions, limits, continuity, differentiation, related rates, optimization, graphing, integration, and volumes.

**Prerequisites:** MATH 119, or MATH 119A and MATH 119B, or appropriate mathematics placement score.

**Terms Typically Offered:** Fall, Spring, Summer.

**MATH 136 Engineering Calculus II 4 Credits**

Continuation of MATH 135 Engineering Calculus I. Emphasis on computational aspects. Includes techniques of integration; trigonometric and hyperbolic functions; inverse, logarithmic, and exponential functions; sequences and series; polar coordinates; and parametric equations.

**Prerequisites:** MATH 135 or MATH 151.

**Terms Typically Offered:** Fall, Spring.

**MATH 141 Analytical Geometry 3 Credits**

College-level treatment of analytic geometry. Topics include the Cartesian coordinate system in two and three dimensions; distance; parallel and perpendicular lines and planes; the locus of a condition; generalizations of lines, circles, and parabolas; polar coordinates; and vectors in two and three dimensions.

**Prerequisites:** MATH 130.

**Terms Typically Offered:** Fall.

**MATH 150 Topics and Careers in Mathematics 1 Credit**

Introduction to the nature of mathematical thinking. Advanced topics and applications of mathematics and statistics will be presented at an introductory level. Career options will be investigated.

**Prerequisites:** MATH 151 or MATH 135 or MATH 131 (any of these courses may be taken concurrently with MATH 150).

**Terms Typically Offered:** Fall, Spring.

**MATH 151 Calculus I-GT-MA1 5 Credits**

Introduction to differentiation and integration of functions of a single variable. Topics include functions, limits, continuity, differentiation, related rates, optimization, graphing, integration, and volumes.

**Prerequisites:** MATH 119, or MATH 119A and MATH 119B, or appropriate mathematics placement test score.

**Essential Learning Categories:** Mathematics See the program requirements list to determine the minimum level math needed  
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**Terms Typically Offered:** Fall, Spring, Summer.

**MATH 152 Calculus II 5 Credits**

Continuation of MATH 151 Calculus I. Topics include techniques of integration; trigonometric and hyperbolic functions; inverse, logarithmic, and exponential functions; sequences and series; polar coordinates; and parametric equations.

**Prerequisites:** MATH 151.

**Terms Typically Offered:** Fall, Spring.

**MATH 196 Topics 1-5 Credits**

Course may be taken multiple times up to maximum of 15 credit hours.

**MATH 205 Elements of Mathematics II-GTMA1 3 Credits**

Continuation of MATH 105 designed for the prospective elementary teacher. Topics include algebraic methods, measurement, decimal numbers, statistics, geometry, and the metric system.

**Prerequisites:** MATH 105 and a planned major in elementary education or early childhood special education.

**Essential Learning Categories:** Mathematics See the program requirements list to determine the minimum level math needed  
**Colorado Guaranteed Transfer (GT) Pathways General Education Curriculum**

**Terms Typically Offered:** Fall, Spring.

**MATH 215 Technology for Mathematics Educators 3 Credits**

Introduction to technology resources appropriate for mathematics educators. Focus is on using spreadsheets to program problem-solving algorithms, mathematical models, and data manipulation. Additional technologies and topics include interactive geometry software, interactive applets, simple webpage design, block-based languages, and educational simulations and games.

**Prerequisites:** MATH 113 and MATH 205.

**Terms Typically Offered:** Spring.

**MATH 225 Computational Linear Algebra 3 Credits**

Computational approach to systems of equations, vector spaces, matrices, matrix transformations, subspaces of  $\mathbb{R}^n$ , eigenvalues, as well as their applications. Software for linear algebra computations is introduced and utilized.

**Prerequisites:** MATH 151 or MATH 135 or MATH 131.

**Terms Typically Offered:** Spring.

**MATH 236 Differential Equations and Linear Algebra 4 Credits**

Introduction to ordinary differential equations and linear algebra. Topics covered include ordinary differential equations, systems of linear equations, matrices, determinants, vector spaces, and systems of linear differential equations.

**Prerequisites:** MATH 152 or MATH 136.

**Terms Typically Offered:** Fall, Spring.

**MATH 240 Introduction to Advanced Mathematics 4 Credits**

Introduction to writing mathematical proofs that provides students with a transition from computation-based lower-level courses to proof-based upper-level courses. Topics include introductory logic, set theory, relations, functions, induction, equivalence relations, and partitions. Emphasis is on constructing and analyzing rigorous mathematical proofs.

**Prerequisites:** MATH 152.

**Terms Typically Offered:** Fall, Spring.

**MATH 253 Calculus III 4 Credits**

Introduction to multivariable calculus. Topics include three-dimensional space, vectors, functions of several variables, partial derivatives, directional derivatives, multiple integrals, vector fields, and the integral theorems of vector calculus.

**Prerequisites:** MATH 136 or MATH 152.

**Terms Typically Offered:** Fall, Spring.

**MATH 260 Differential Equations 3 Credits**

Techniques of solving first and second order differential equations, linear differential equations, and non-homogeneous differential equations, including variation of parameters, series solutions, and Laplace transform methods.

**Prerequisites:** MATH 152 or MATH 136.

**Terms Typically Offered:** Spring.

**MATH 296 Topics 1-3 Credits**

Course may be taken multiple times up to maximum of 15 credit hours.

**MATH 301 Mathematics for Elementary Teachers 3 Credits**

Selection of mathematics topics addressing content and standards for elementary education, including problem solving, probability, mathematical standards and current research, technology, and additional review topics. Strong emphasis on written and oral communication.

**Prerequisites:** MATH 205; and formal acceptance into the Teacher Education Program or consent of the instructor.

**Terms Typically Offered:** Fall, Spring.

**MATH 305 Discovering Geometry 3 Credits**

Development of Euclidean Geometry through exploration and inductive reasoning. Basic concepts of proofs are introduced. Topics include angles and shapes; constructions; perimeter, area, and volume; congruence and similarity conditions; symmetry and tessellations; and applications of technology. Intended for students seeking elementary teacher licensure.

**Prerequisites:** MATH 301.

**Terms Typically Offered:** Fall.

**MATH 310 Number Theory 3 Credits**

Introduction to classical number theory. Topics include the Fundamental Theorem of Arithmetic, congruences, and linear Diophantine equations.

**Prerequisites:** MATH 240.

**Terms Typically Offered:** Fall.

**MATH 325 Linear Algebra 3 Credits**

Proof-based treatment of linear algebra. Topics include vector spaces, linear transformations, eigenvalues, and orthogonality.

**Prerequisites:** MATH 225 and MATH 240.

**Terms Typically Offered:** Fall.

**MATH 340 Ethnomathematics 3 Credits**

Study of the relationship between mathematics and culture, with an emphasis on small-scale indigenous cultures. Topics include mathematics systems, their logical structures, and their modes of expression through the lens of culture.

**Prerequisites:** MATH 240 or MATH 301.

**Terms Typically Offered:** Fall.

**MATH 352 Advanced Calculus 3 Credits**

Proof-based treatment of calculus of one real variable, with focus on axiomatic development. Topics include completeness of the real numbers, limits, continuity, derivatives, integrals, and the Fundamental Theorem of Calculus.

**Prerequisites:** MATH 240.

**Terms Typically Offered:** Spring.

**MATH 360 Methods of Applied Mathematics 3 Credits**

Introduction to methods of applied analysis and mathematical physics. Topics include vector calculus, Sturm-Liouville problems, Fourier series, partial differential equations, series solutions of ordinary differential equations, and special functions.

**Prerequisites:** MATH 253, and MATH 236 or MATH 260.

**Terms Typically Offered:** Fall.

**MATH 361 Numerical Analysis 4 Credits**

Introduction to the study of accuracy and efficiency of algorithms and numerical computation. Topics include computer representation of numbers, finite precision arithmetic, truncating errors, iteration processes, numerical solutions of algebraic and transcendental equations, systems of linear equations, Taylor polynomial approximation, interpolation, finite differences, numerical integration, and error analysis.

**Prerequisites:** MATH 152 or MATH 136.

**Terms Typically Offered:** Fall.

**MATH 362 Fourier Analysis 3 Credits**

Introduction to continuous and discrete Fourier analysis. Topics include representation of signals as vectors, matrices, and functions; orthogonal expansions; Fourier series and frequency analysis; thresholding and compression; Fourier and inverse Fourier transforms; discrete and inverse discrete Fourier transforms; and cosine transforms.

**Prerequisites:** MATH 152 or MATH 136.

**Terms Typically Offered:** Fall.

**MATH 365 Mathematical Modeling 3 Credits**

Bridge between calculus and the application of mathematics. Investigation of meaningful and practical problems encompassing the disciplines of mathematical sciences, operations research, engineering, management sciences and life sciences.

**Prerequisites:** MATH 136 or MATH 152, and one of the following: MATH 225, MATH 236, MATH 240, MATH 253, MATH 260, or STAT 200.

**Terms Typically Offered:** Spring.

**MATH 366 Methods of Applied Mathematics II 3 Credits**

Treatment of numerical methods used to solve problems in applied mathematics. Topics include iteration; interpolation and cubic splines; numerical integration and differentiation; numerical linear algebra; and numerical solutions of ordinary and partial differential equations.

**Prerequisites:** MATH 360; and CSCI 110/CSCI 110L or CSCI 111 or CSCI 130 or CSCI 310.

**Terms Typically Offered:** Spring.

**MATH 369 Discrete Structures I 3 Credits**

Introduction to discrete mathematics. Topics include elementary logic, set theory, number theory, public-key cryptography, complexity of algorithms, induction and recursion, combinatorics, relations, and graphs.

**Prerequisites:** MATH 152 or MATH 136; and CSCI 110/CSCI 110L or CSCI 111 or CSCI 130.

**Terms Typically Offered:** Fall, Spring.

**MATH 380 History of Mathematics 3 Credits**

History of mathematics from antiquity to the present, with emphasis upon the development of mathematics concepts and the people involved.

**Prerequisites:** MATH 152.

**Terms Typically Offered:** Fall.

**MATH 386 Geometries 4 Credits**

Study of Euclidean and non-Euclidean geometries. This course distinguishes Euclidean and non-Euclidean geometries according to their axiom systems and their models, and examines how notions in Euclidean geometry are interpreted in non-Euclidean systems. Topics include axiomatic systems, parallelism, area, congruence, similarity, transformations, and symmetry.

**Prerequisites:** MATH 240.

**Terms Typically Offered:** Spring.

**MATH 389 Explorations in Mathematics for Elementary Educators 2 Credits**

Exploration of diverse topics and fields of mathematics to broaden the perspectives of future elementary educators. Exposure to and a deeper understanding of a wide variety of topics will be established through directed readings, explorations, and discussions.

**Prerequisites:** MATH 301.

**Terms Typically Offered:** Spring.

**MATH 395 Independent Study 1-3 Credits**

Course may be taken multiple times up to maximum of 6 credit hours.

**MATH 396 Topics 1-3 Credits**

Course may be taken multiple times up to maximum of 15 credit hours.

**MATH 397 Structured Research 1-4 Credits**

Mathematical research under the direct guidance of a faculty member. Designed for junior and senior level students.

**Prerequisites:** Permission of instructor.

Course may be taken multiple times up to maximum of 12 credit hours.

**MATH 420 Introduction to Topology 3 Credits**

Introduction to point set topology. Topics include topological spaces, continuity, metric spaces, connectedness, compactness, and the separation axioms.

**Prerequisites:** MATH 310 or MATH 325 or MATH 352.

**Terms Typically Offered:** Spring.

**MATH 430 Mathematical Logic 3 Credits**

Introduction to the classical areas of mathematical logic (model theory, proof theory, the theory of computation, complexity theory, and set theory) and the relationships these sub-disciplines have with each other and with the foundations of mathematics, computational science, computer science, and the philosophy of mathematics.

**Prerequisites:** MATH 240 or MATH 369.

**Terms Typically Offered:** Fall.

**MATH 450 Complex Variables 3 Credits**

Introduction to complex analysis. Topics include the algebra of complex numbers; elementary functions of a complex variable; analyticity; differentiation and integration of complex functions; Cauchy's Integral Formula; and series representations of analytic functions.

**Prerequisites:** MATH 240.

**Terms Typically Offered:** Fall.

**MATH 452 Introduction to Real Analysis I 3 Credits**

Introduction to real analysis from a general metric space perspective.

Topics may include: point set topology, completeness, compactness, connected sets, sequences, limits of functions, continuity, differentiation, integration, and sequences of functions.

**Prerequisites:** MATH 352.

**Terms Typically Offered:** Fall.

**MATH 453 Introduction to Real Analysis II 3 Credits**

Exploration of advanced topics in real analysis. Specific topics are determined by the instructor and may include differentiation and integration of functions of multiple variables; inverse and implicit function theorems; dynamical systems and chaos; and Banach and Hilbert spaces.

**Prerequisites:** MATH 452.

**Terms Typically Offered:** Spring.

**MATH 460 Advanced Linear Algebra 3 Credits**

Exploration of advanced topics in linear algebra. Specific topics are determined by the instructor and may include characteristic and minimal polynomials, the Cayley-Hamilton Theorem, the Jordan canonical form, quotient spaces, and dual vector spaces.

**Prerequisites:** MATH 325.

**Terms Typically Offered:** Spring.

**MATH 466 Methods of Applied Mathematics III 3 Credits**

Exploration of advanced methods of applied mathematics, with an emphasis on extending basic methods and concepts, including modeling applied problems, determining analytical solutions, and implementing numerical methods. Specific content may vary but will typically include contemporary techniques in applied mathematics.

**Prerequisites:** MATH 366.

**Terms Typically Offered:** Fall.

**MATH 490 Abstract Algebra I 3 Credits**

Introduction to the theory of algebraic structures. Topics include groups, subgroups, cyclic groups, groups of permutations, homomorphisms, isomorphisms, the order of group elements, cosets, quotient structures, isomorphism theorems, and an introduction to rings and fields.

**Prerequisites:** MATH 310.

**Terms Typically Offered:** Spring.

**MATH 491 Abstract Algebra II 3 Credits**

Continuation of MATH 490 Abstract Algebra I, focusing on rings and fields. Topics include rings, ideals, quotient structures, ring homomorphisms, integral domains, polynomial rings, fields, field extensions, finite fields, and Galois Theory.

**Prerequisites:** MATH 490.

**Terms Typically Offered:** Fall.

**MATH 492 Senior Capstone 3 Credits**

Exploration and communication of mathematical ideas and problems relevant to individual mathematics concentrations by integrating and extending material covered in mathematics coursework. Investigations may also include placing mathematics in historical, applied, professional, and social contexts.

**Prerequisites:** Senior standing.

**Terms Typically Offered:** Fall.

**MATH 495 Independent Study 1-3 Credits**

Course may be taken multiple times up to maximum of 6 credit hours.

**MATH 496 Topics 1-3 Credits**

Course may be taken multiple times up to maximum of 15 credit hours.

**MATH 500 Introduction to Graduate Studies in Applied Mathematics 3 Credits**

Introduction to methods and concepts of applied mathematics, including differentiation and integration of single and multivariate functions, vector calculus methods, matrix-vector computations, vector space concepts, and mathematical proofs.

**Prerequisites:** Acceptance into the Graduate Certificate in Applied Mathematics program.

**MATH 510 Applied Probability and Statistics 3 Credits**

Develop a comprehension of, and an ability to perform, statistical methods that are most common in educational research. Emphases on statistical concepts that will further prepare teachers to teach introductory-level college statistics and critically examine and comprehend the data analysis in educational literature. Graphing calculators and computer software may be used to analyze and display data.

**Prerequisites:** Acceptance into the Graduate Certificate in Applied Mathematics program.

**MATH 520 Applied Numerical Methods 3 Credits**

Exploration of fundamental algorithms and analysis of numerical methods commonly used by scientists, engineers, and mathematicians to approximately solve mathematical problems that are analytically impossible or intractable.

**Prerequisites:** MATH 500.

**MATH 530 Applied Mathematical Modeling 3 Credits**

Investigation of applications of mathematics in the natural and social sciences, involving continuous, discrete, and probabilistic models. Survey of historical applications of mathematics in fields including chemistry, engineering, finance, ecology, and management; and creation of new models to address current questions in these fields. Involves model creation and model selection, analytical and computational methods of solving a model, and presentation of original work in a seminar setting.

**Prerequisites:** MATH 500.

**MATH 540 Applied Audio and Image Processing 3 Credits**

Investigation of the mathematics behind the processing of sound waves and digital images. Both theory and computer-based applications will be explored, using methods of calculus, matrix-vector algebra, and inner product spaces.

**Prerequisites:** MATH 500.

**MATH 550 Mathematical Logic and Foundations in Mathematics 3 Credits**

Study of logical systems, formal languages, satisfaction, deduction, correctness, completeness, applications to algebraic structures and orderings, construction of ordinal and cardinal numbers within axiomatic set theory, models of computation, undecidability, computational complexity, intractability, and introduction to themes within the philosophy of mathematics.

**Prerequisites:** Acceptance into the Graduate Certificate in Applied Mathematics program.

**MATH 560 Applied Number Theory 3 Credits**

Applied treatment of number theory including prime numbers, congruences, quadratic residues and primitive roots.

**Prerequisites:** Acceptance into the Graduate Certificate in Applied Mathematics program.

**MATH 570 Applied Cryptography 3 Credits**

Exploration of cryptography. Topics include number theory, classical ciphers, integer factorization, primality testing, public-key ciphers, digital signatures schemes, commitment schemes, elliptic curve methods, and applications to e-commerce. Additional topics upon student interest.

**Prerequisites:** MATH 560.

**MATH 596 Topics 1-3 Credits**

Course may be taken multiple times up to maximum of 15 credit hours.