

## MATH - Mathematics

**Courses numbered 000–099 do not count toward any degree program.**

Courses numbered 100 to 299 = *lower-division*; 300 to 499 = *upper-division*; 500 to 799 = *undergraduate/graduate*.

### **MATH 007. Arithmetic (3).** †

A review and study of the basic arithmetic operations for the mature student whose previous training in arithmetic is inadequate for completion of college mathematics courses.

### **MATH 011. Beginning Algebra (5).**

Content consists of algebra topics usually covered in the first year of a standard high school algebra course. Not applicable to degree.

### **MATH 012. Intermediate Algebra (3-5).** †

Content consists of topics usually covered in the second year of a standard high school algebra course. Not applicable to degree. This is a Kansas Systemwide Transfer Course. Prerequisite(s): MATH 011 or one year of high school algebra, and qualifying score in recent department placement exam.

### **MATH 111. College Algebra (3).** †

*General education foundation course.* Surveys functions, theory of equations and inequalities, complex numbers, and exponential and logarithmic functions. High school geometry is a highly recommended preparatory course. Students may earn credit for only one of the following courses: MATH 111, MATH 111S, or MATH 112. This is a Kansas Systemwide Transfer Course. Prerequisite(s): qualifying score in relevant placement exam (ACT, SAT, ALEKS) or qualifying HS math enrollment per KBOR systemwide math placement guidelines.

### **MATH 111S. College Algebra with Support (3).** †

*General education foundation course.* Surveys functions, theory of equations and inequalities, complex numbers, and exponential and logarithmic functions. The course carries 3 credit hours but requires 5 contact hours per week for comprehensive support. High school geometry is a highly recommended preparatory course. Students may earn credit for only one of the following courses: MATH 111, MATH 111S, or MATH 112.

### **MATH 112. Precalculus Mathematics (5).**

*General education foundation course.* Functions, theory of equations and inequalities, complex numbers, the trigonometric functions, exponential and logarithmic functions, and other standard topics prerequisite to a beginning study of calculus. Course is not available for credit to students who have received a C or better in MATH 242 or its equivalent. Students may earn credit for only one of the following courses: MATH 111, MATH 111S or MATH 112. Prerequisite(s): qualifying score in relevant placement exam (ACT, SAT, ALEKS) or qualifying HS math enrollment per KBOR systemwide math placement guidelines.

### **MATH 121. Geometry for College Students (3).**

A study of lines, angle relationships, parallel lines, triangles, quadrilaterals, similar triangles, circles, areas of polygons and circles, and some material on surface and solids. Prerequisite(s): MATH 111 or equivalent with a grade of C or better.

### **MATH 123. College Trigonometry (3).** †

Studies the trigonometric functions and their applications. Credit in both MATH 123 and 112 is not allowed. This is a Kansas Systemwide Transfer Course. Prerequisite(s): MATH 111 with C or better or equivalent high school preparation and one unit of high school geometry.

### **MATH 131. Contemporary Mathematics (3).** †

*General education foundation course.* For students majoring in nontechnical areas. A collection of applications of mathematics illustrating how contemporary mathematical thinking is used in the decision-making process. Covers topics selected from such areas as the mathematics of social choice, management science, statistics, coding information, and the geometry of growth, shape and symmetry. Students may earn credit for only one of the following courses: MATH 131 or MATH 131S. This is a Kansas Systemwide Transfer Course. Prerequisite(s): qualifying score in relevant placement exam (ACT, SAT, ALEKS) or qualifying HS math enrollment per KBOR systemwide math placement guidelines.

### **MATH 131S. Contemporary Mathematics with Support (3).** †

*General education foundation course.* For students majoring in nontechnical areas. A collection of applications of mathematics illustrating how contemporary mathematical thinking is used in the decision-making process. Covers topics selected from such areas as the mathematics of social choice, management science, statistics, coding information, and the geometry of growth, shape and symmetry. The course carries 3 credit hours but requires 5 contact hours per week for comprehensive support. Students may earn credit for only one of the following courses: MATH 131 or MATH 131S.

### **MATH 144. Business Calculus (3).** †

*General education math course.* A brief but careful introduction to calculus for students of business and economics. Students may receive credit for one of these courses: MATH 144, 242 or 251. This is a Kansas Systemwide Transfer Course. Prerequisite(s): MATH 111 or 112 with a C or better, or equivalent high school preparation.

### **MATH 231. Discrete Math (3).**

A study of some of the basic topics of discrete mathematics, including elementary logic, properties of sets, mathematical induction, counting problems using permutations and combinations, trees, elementary probability, and an introduction to graph theory. Prerequisite(s): MATH 111 or equivalent with a grade point of 2.000 or better.

### **MATH 242. Calculus I (5).** †

*General education math course.* Analytic geometry and the calculus in an interrelated form. Students may receive credit for only one of these courses: MATH 144, 242 or 251. This is a Kansas Systemwide Transfer Course. Prerequisite(s): MATH 112 with a C or better, or two units of high school algebra, one unit of high school geometry and one-half unit of high school trigonometry, or MATH 123 and 111 with a C or better in each.

### **MATH 242H. Calculus I Honors (5).** †

*General education math course.* Analytic geometry and the calculus in an interrelated form. Students may receive credit for only one of these courses: MATH 144, 242 or 251. This is a Kansas Systemwide Transfer Course. Prerequisite(s): MATH 112 with a C or better, or two units of high school algebra, one unit of high school geometry and one-half unit of high school trigonometry, or MATH 123 and 111 with a C or better in each.

### **MATH 243. Calculus II (5).** †

*General education math course.* Continuation of MATH 242. Includes a study of integration and applications and an introduction to infinite series. Credit in both MATH 243 and 252 is not allowed. Prerequisite(s): MATH 242 with a C or better.

### **MATH 243H. Calculus II Honors (5).** †

*General education math course.* Continuation of MATH 242. Includes a study of integration and applications and an introduction to infinite series. Credit in both MATH 243 and 252 is not allowed. Prerequisite(s): MATH 242 with a C or better.

**MATH 252. Technical Calculus II (3).**

Standard topics in analytic geometry and calculus, including topics in multidimensional calculus and differential equations with applications to engineering technology. This course is intended for students in the engineering technology program. Credit in both MATH 252 and 243 is not allowed. Prerequisite(s): MATH 251 with a C or better, or MATH 242 with C or better, or equivalent preparation.

**MATH 300. Evolution of Mathematics (3).**

A study of mathematics and mathematicians from antiquity to the present, to see how mathematics has developed from human beings' efforts to understand the world and the extent to which mathematics has molded our civilization and culture. Since mathematics is what mathematicians do, the lives of mathematicians from various ages and countries are studied. Not a mathematical skills course.

**MATH 321. Discrete Structures I (3).**

Provides a mathematical foundation essential to the entire computer science curriculum. Includes propositional and predicate logic, induction, recursion and counting techniques. Prerequisite(s): MATH 242 or equivalent with a grade of 2.000 or better.

**MATH 322. Discrete Structures II (3).**

Continuation of Discrete Structures I. Includes relations, graphs, trees, Boolean algebra and automata. Prerequisite(s): MATH 321.

**MATH 344. Calculus III (3).**

*General education math course.* Continuation of MATH 243. Includes a study of multiple integration and partial derivatives. Prerequisite(s): MATH 243 with a grade point of 2.000 or better.

**MATH 344H. Calculus III Honors (3).**

*General education math course.* Continuation of MATH 243. Includes a study of multiple integration and partial derivatives. Prerequisite(s): MATH 243 with a grade point of 2.000 or better.

**MATH 415. An Introduction to Advanced Mathematics (3).**

Develops the concept of proof in a setting of mathematical tools needed in advanced courses. Covers topics in number theory, algebra and analysis. Particular attention to equivalence relations, functions, induction and mathematical systems. Prerequisite(s): MATH 344 with a grade point of 2.000 or better.

**MATH 451. Computational Mathematics Using MATLAB (3).**

Introduces the use of MATLAB in computational algorithms. A bridge to upper-division courses in numerical methods and applied mathematics. Prerequisite(s): MATH 243 with a grade point of 2.000 or better.

**MATH 480. Individual Projects (1-5).**

An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 480A, 480B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): departmental consent.

**MATH 481. Cooperative Education (1-6).**

Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Prerequisite(s): departmental consent.

**MATH 501. Elementary Mathematics (5).**

A study of topics necessary to an understanding of the elementary school curriculum, such as set theory, real numbers and geometry. Not for major or minor credit. Prerequisite(s): elementary education major and MATH 111 or equivalent with a grade point of 2.000 or better, or departmental consent.

**MATH 502. Mathematics for Middle School Teachers (5).**

A study of the mathematical knowledge which forms the theoretical foundations of, the applications of, and extensions of middle school mathematics. This capstone course serves to reinforce mathematics skills learned in prerequisite courses and assists students in recognizing the unifying principles within their mathematical experiences. Prerequisite(s): MATH 111, 121, 123, 144, 501, and STAT 370 or equivalent with a grade point of 2.000 or better in each.

**MATH 511. Linear Algebra (3).**

An elementary study of linear algebra, including an examination of linear transformations and matrices over finite dimensional spaces. Prerequisite(s): MATH 243 with a grade point of 2.000 or better.

**MATH 530. Applied Combinatorics (3).**

Basic counting principles, occupancy problems, generating functions, recurrence relations, principles of inclusion and exclusion, the pigeonhole principle, Fibonacci sequences and elements of graph theory. Prerequisite(s): MATH 344 with a grade point of 2.000 or better.

**MATH 531. Introduction to the History of Mathematics (3).**

Studies the development of mathematics from antiquity to modern times. Solves problems using the methods of the historical period in which they arose. Requires mathematical skills. Prerequisite(s): MATH 511 and two additional courses at the 500 level or above, with a grade point of 2.000 or better in each.

**MATH 547. Advanced Calculus I (3).**

Covers the calculus of Euclidean space including the standard results concerning functions, sequences and limits. Prerequisite(s): MATH 344 and 415 with a grade point of 2.000 or better in each.

**MATH 548. Introduction to Complex Variables (3).**

Study of complex numbers, analytic functions, differentiation and integration of complex functions, line integrals, power series, residues and poles, and conformal mapping with applications. Prerequisite(s): MATH 344 with a grade point of 2.000 or better.

**MATH 551. Numerical Methods (3).**

Approximating roots of equations, interpolation and approximation, numerical differentiation and integration, and the numerical solution of first order ordinary differential equations. Some computer use. Prerequisite(s): MATH 344 and 451 with a grade point of 2.000 or better, or departmental consent.

**MATH 553. Mathematical Models (3).**

Covers case studies from the fields of engineering technology and the natural and social sciences. Emphasizes the mathematics involved. Each student completes a term project which is the solution of a particular problem approved by the instructor. Prerequisite(s): Math 344 with a grade point of 2.000 or better, or departmental consent.

**MATH 555. Differential Equations I (3). †**

A study of first order equations including separation of variables and exact equations, second order equations including the general theory of initial value problems, constant coefficients, undetermined coefficients, variation of parameters and special methods of solution using power series and the Laplace transform methods. A standard course in differential equation for students in the sciences and engineering. Prerequisite(s): MATH 243 with a grade point of 2.000 or better, or departmental consent.

**MATH 555H. Differential Equations I Honors (3). †**

A study of first order equations including separation of variables and exact equations, second order equations including the general theory of initial value problems, constant coefficients, undetermined coefficients, variation of parameters and special methods of solution using power series and the Laplace transform methods. A standard course in

differential equation for students in the sciences and engineering. Prerequisite(s): MATH 243 with a grade point of 2.000 or better, or departmental consent.

**MATH 580. Selected Topics In Math (1-3).**

An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 580A, 580B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): departmental consent.

**MATH 580AA. Introduction to Partial Differential Equations (3).**

Introduction to the basic properties of partial differential equations and to the techniques that have proved useful in analyzing them. The purpose of this course is to provide for the student a broad perspective on the subject, to illustrate the rich variety of phenomena encompassed by it, and to impart a working knowledge of the most important techniques of analysis of the solutions of the equations. Prerequisite(s): MATH 344.

**MATH 580B. Introduction to Elementary Differential Geometry: A First Course in Curves and Surfaces (3).**

Introduction to the theory of curves and surfaces. Prerequisite(s): MATH 344, MATH 415 and MATH 511; MATH 525 is recommended, but not required. Pre- or corequisite(s): MATH 547.

**MATH 613. Fundamental Concepts of Algebra (3).**

Defines group, ring and field, and studies their properties. Prerequisite(s): MATH 415 and MATH 511 with a grade point of 2.000 or better, or departmental consent.

**MATH 615. Elementary Number Theory (3).**

Studies properties of the integers by elementary means. Prerequisite(s): MATH 344 with a grade point of 2.000 or better, or departmental consent.

**MATH 620. Introduction to Elementary Differential Geometry: A First Course in Curves and Surfaces (3).**

Introduction to the theory of curves and surfaces. Prerequisite(s): MATH 511, (MATH 525 recommended). Pre- or corequisite(s): MATH 547.

**MATH 621. Elementary Geometry (3).**

Studies Euclidean geometry from an advanced point of view. Prerequisite(s): MATH 344 with a grade point of 2.000 or better, or departmental consent.

**MATH 625. Elementary Topology (3).**

Studies topological spaces, open and closed sets, bases for topology, continuous mappings, homeomorphisms, connectedness and compactness, Hausdorff and other spaces, with special emphasis on metric spaces. Prerequisite(s): MATH 415 with a grade point of 2.000 or better.

**MATH 640. Advanced Calculus II (3).**

A further study of the calculus of Euclidean space including integration theory and multidimensional differentiation. Prerequisite(s): MATH 511 and MATH 547 with a grade point of 2.000 or better in each.

**MATH 646. Introduction to Mathematical Data Analysis (3).**

Introduces basic mathematical tools and principles for data analysis techniques used in analyzing data sets. Topics include matrix decomposition, gradient descent, continuous optimization, linear regression, dimension reduction and clustering. For students to be successful in this course, basic calculus and statistics knowledge is needed prior to enrolling. Prerequisite(s): departmental consent.

**MATH 655. Differential Equations II (3).**

A continuation of MATH 555 (but with more emphasis on theoretical issues) that covers higher order differential equations, systems of first order equations (including the basics of linear algebra), some numerical methods, and stability and behavior of solutions for large times. Prerequisite(s): MATH 555 with a grade point of 2.000 or better, or departmental consent.

**MATH 657. Optimization Theory (3).**

Introduces selected topics in linear and nonlinear optimization. Develops the revised simplex method along with a careful treatment of duality. Then extends the theory to solve parametric, integer and mixed integer linear programs. Prerequisite(s): MATH 511 with a grade point of 2.000 or better.

**MATH 713. Abstract Algebra I (3).**

Treats the standard basic topics of abstract algebra. Prerequisite(s): MATH 613 with a grade point of 2.000 or better, or departmental consent.

**MATH 720. Modern Geometry (3).**

Introduction to smooth manifolds with heavy emphasis on surfaces as a primary example. Prerequisite(s): MATH 620 with a grade point of 2.500 or better, or departmental consent.

**MATH 725. Topology I (3).**

Studies the results of point set and algebraic topology. Prerequisite(s): MATH 547 with a grade point of 2.000 or better, or departmental consent.

**MATH 743. Real Analysis I (3).**

Includes a study of the foundations of analysis and the fundamental results of the subject. Prerequisite(s): MATH 640 with a grade point of 2.000 or better, or departmental consent.

**MATH 745. Complex Analysis I (3).**

Studies the theory of analytic functions. Prerequisite(s): MATH 640 with a grade point of 2.000 or better, or departmental consent.

**MATH 746. Introduction to Data Analytics (3).**

Covers basic mathematical techniques for analyzing data sets. Uses object oriented programming, like Python or R, to show how to organize, visualize and analyze large data. For students to be successful in this course, basic programming knowledge is needed prior to enrolling. Prerequisite(s): MATH 511, 571, or instructor's consent.

**MATH 750Y. Smooth Manifolds (3).**

Knowledge of differentiable manifolds has become very important in a large number of areas of mathematics and of its applications. In fact, much of advanced calculus and analysis is based on the study of differentiable manifolds. For example, topics such as line and surface integrals, divergence and curl of vector fields and Stokes' and Green's theorems are most naturally described using manifold theory. Course gives a careful introduction to differentiable manifolds, illustrating each new definition and theorem with the study of spheres, tori, real and complex projective spaces, and matrix groups. Talks about tangent spaces, vector fields, differential forms and integral curves. Concludes with Stokes' theorem on manifolds.

**MATH 750Z. Data Analytics' (3).**

Covers basic mathematical techniques for analyzing data sets. The course will use Python to show how to organize, visualize, and analyze large data. Prerequisite(s): MATH 511, STAT 571, basic programming knowledge.

**MATH 751. Numerical Linear Algebra (3).**

Includes analysis of direct and iterative methods for the solution of linear systems, linear least squares problems, Eigenvalue problems, error analysis, and reduction by orthogonal transformations.

Prerequisite(s): MATH 511, 547, 551 with a grade point of 2.000 or better in each, or departmental consent.

**MATH 753. Ordinary Differential Equations (3).**

Covers existence, uniqueness, stability and other qualitative theories of ordinary differential equations. Prerequisite(s): MATH 547 with a grade point of 2.000 or better, or departmental consent.

**MATH 755. Partial Differential Equations I (3).**

Studies the existence and uniqueness theory for boundary value problems of partial differential equations of all types. Prerequisite(s): MATH 547 with a grade point of 2.000 or better, or departmental consent.

**MATH 757. Partial Differential Equations for Engineers (3).**

Includes Fourier series, the Fourier integral, boundary value problems for the partial differential equations of mathematical physics, Bessel and Legendre functions, and linear systems of ordinary differential equations. Prerequisite(s): MATH 555 with a grade point of 2.000 or better.

**MATH 758. Complex and Vector Analysis for Engineers (3).**

A survey of some of the mathematical techniques needed in engineering including an introduction to vector analysis, line and surface integrals, and complex analysis, contour integrals and the method of residues. Not applicable toward a graduate degree in mathematics. Prerequisite(s): MATH 555 with a grade point of 2.000 or better.

**MATH 781. Cooperative Education (1-3).**

Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Repeatable for credit. May not be used to satisfy degree requirements. Prerequisite(s): departmental consent, graduate GPA of 3.000 or above.