Mathematics (MATH)

Courses

MATH 0001L. College Algebra Laboratory I. 1 Hour.
This course provides additional support and instruction for students enrolled in MATH 1203 who are required to take it based on the placement requirements stipulated for that course. Credit earned in this course will not be applied to the total hours required for a degree. One lab hour.

MATH 0002L. College Algebra Laboratory II. 2 Hours.
This course provides additional support and instruction for students enrolled in MATH 1203 who are required to take it based on the placement requirements stipulated for that course. Credit earned in this course will not be applied to the total hours required for a degree. Two lab hours.

MATH 0131L. Quantitative Reasoning Laboratory. 1 Hour.
This course provides additional support and instruction for students enrolled in MATH 1313 who are required to take it based on the placement requirements stipulated for that course. Credit earned in this course will not be applied to the total hours required for a degree. One lab hour.

MATH 1203. College Algebra (ACTS Equivalency = MATH 1103). 3 Hours.
Topics include the solution and application of linear and quadratic equations and inequalities; functions, graphs, and theory of equations; matrix solutions of systems of equations and basic properties of matrices. Prerequisite: a score of at least 80% on the University of Arkansas Preparedness for Algebra exam, or a score of at least 23 on the math component of the ACT exam, or a score of at least 570 on the math component of the new SAT or 540 on the math component of the old SAT. Students who score at least 70% on the University of Arkansas Preparedness for Algebra exam, or at least 19 on the math component of the ACT exam, or at least 510 on the math component of the new SAT or 460 on the math component of the old SAT must also register for MATH 0001L as a corequisite. Students who score below 70% on the University of Arkansas Preparedness for Algebra exam, or below 19 on the math component of the ACT exam, or below 510 on the math component of the new SAT or 460 on the math component of the old SAT must also register for MATH 0002L as a corequisite.

MATH 1204. College Algebra with Review (ACTS Equivalency = MATH 1103). 4 Hours.
Same as MATH 1203 with additional support, increased class time, additional review, and computerized lab component. Prerequisite: MATH 0003 with a grade of D or better, or a score of at least 70% on the University of Arkansas Preparedness for Algebra Exam, or a score of at least 19 on the math component of the ACT exam, or a score of at least 460 on the math component of the old SAT or 500 on the math component of the new SAT.
This course is equivalent to MATH 1203.

MATH 1213. Plane Trigonometry (ACTS Equivalency = MATH 1203). 3 Hours.
Basic topics in trigonometry including identities, formulas, and polar coordinate system. Credit will be allowed for only one of either MATH 1213 or MATH 1284C. Prerequisite: MATH 1203 or MATH 1204 with a grade of C or better, or a score of at least 80% on the University of Arkansas Mastery of Algebra Exam, or a score of at least 26 on the math component of the ACT exam, or a score of at least 600 on the math component of the old SAT or 620 on the math component of the new SAT.

MATH 1284C. Precalculus Mathematics (ACTS Equivalency = MATH 1305). 4 Hours.
Topics in algebra and trigonometry. To be taken by students who expect to take MATH 2554. Corequisite: Drill component. Prerequisite: MATH 1203 or MATH 1204 with a grade of C or better, or a score of at least 80% on the University of Arkansas Mastery of Algebra Exam, or a score of at least 26 on the math component of the ACT exam, or a score of at least 600 on the math component of the old SAT or 620 on the math component of the new SAT.

MATH 1313. Quantitative Reasoning (ACTS Equivalency = MATH 1113). 3 Hours.
Reasoning about quantitative information, and the use of mathematical tools and models as citizens, consumers, entrepreneurs and employees in today’s complex technological society. Topics include modeling with functions; quantity, measurement and indices; finance; counting, probability, odds and risk. Prerequisite: a score of at least 70% on the University of Arkansas Preparedness for Algebra exam, or a score of at least 19 on the math component of the ACT exam, or a score of at least 510 on the math component of the new SAT or 460 on the math component of the old SAT. Students who score below 70% on the University of Arkansas Preparedness for Algebra exam, or below 19 on the math component of the ACT exam, or below 510 on the math component of the new SAT or below 460 on the math component of the old SAT must also register for MATH 0131L as a corequisite.

MATH 1514. Calculus with Algebra and Trigonometry I. 4 Hours.
Topics in algebra, trigonometry and precalculus are integrated with elementary differential calculus. Part of a two semester sequence with MATH 2514; these two courses together are equivalent to MATH 1284C and MATH 2554C. MATH 1514 BY ITSELF NOT EQUIVALENT TO EITHER MATH 1284C OR MATH 2554C. This course must be taken with MATH 2514. Intended for students who place into MATH 1284C, but who would profit from an earlier exposure to calculus concepts. Closed to students with credit for MATH 2554C. Prerequisite: MATH 1203 or MATH 1204 with a grade of C or better, or a score of at least 80% on the University of Arkansas Mastery of Algebra Exam, or a score of at least 26 on the math component of the ACT exam, or a score of at least 600 on the math component of the old SAT or 620 on the math component of the new SAT.

MATH 2031M. Honors Mathematical Thought Lab. 1 Hour.
Supplemental honors laboratory for MATH 2033, Mathematical Thought. Pre- or Corequisite: MATH 2033. Prerequisite: Honors standing or departmental consent.

MATH 2033. Mathematical Thought. 3 Hours.
This course introduces students to a variety of topics in modern mathematics. Topics vary and can include graph theory, game theory, voting systems, foundations of logic, cardinality, discrete geometry, combinatorics, geometry of surfaces, topology and symmetry. Prerequisite: MATH 1203 or MATH 1204 with a grade of C or better, or a score of at least 80% on the University of Arkansas Mastery of Algebra Exam, or a score of at least 26 on the math component of the ACT exam, or a score of at least 600 on the math component of the old SAT or 620 on the math component of the new SAT.

MATH 2043. Survey of Calculus (ACTS Equivalency = MATH 2203). 3 Hours.
Selected topics in elementary calculus and analytic geometry for students in business, agriculture, and social sciences. Credit will be allowed for only one of MATH 2043 and MATH 2554. Prerequisite: MATH 1203 or MATH 1204 or MATH 1213 or MATH 1284C or MATH 2053 with a grade of C or better, or a score of at least 80% on the University of Arkansas Mastery of Algebra Exam, or a score of at least 26 on the math component of the ACT exam, or a score of at least 600 on the math component of the old SAT or 620 on the math component of the new SAT.

MATH 2043C. Survey of Calculus. 3 Hours.
Selected topics in elementary calculus and analytic geometry for students in business, agriculture, and social sciences. Credit will be allowed for only one of MATH 2043 and MATH 2554. Corequisite: Drill component. Prerequisite: MATH 1203 or MATH 1204 or MATH 1213 or MATH 1284C or MATH 2053 with a grade of C or better, or a score of at least 80% on the University of Arkansas Mastery of Algebra Exam, or a score of at least 26 on the math component of the ACT exam, or a score of at least 600 on the math component of the old SAT or 620 on the math component of the new SAT.

This course is equivalent to MATH 2043.
MATH 2053. Finite Mathematics. 3 Hours.
Selected topics in probability and statistics, review of algebraic matrices, and
graphic analysis of linear programming for students in business, agriculture,
and social sciences. Prerequisite: MATH 1203 or MATH 1204 or MATH 1213 or
MATH 1284C or MATH 2043 with a grade of C or better, or a score of at least 80%
on the University of Arkansas Mastery of Algebra Exam, or a score of at least 26
on the math component of the ACT exam, or a score of at least 600 on the math
component of the old SAT or 620 on the math component of the new SAT.

MATH 2053C. Finite Mathematics. 3 Hours.
Selected topics in probability and statistics, review of algebraic matrices, and
graphic analysis of linear programming for students in business, agriculture, and
social sciences. Taught with a two-day-per-week lecture and one-day-per-week
drill. Corequisite: Drill component. Prerequisite: MATH 1203 or MATH 1204 or
MATH 1213 or MATH 1284C or MATH 2043 with a grade of C or better, or a score
of at least 80% on the University of Arkansas Mastery of Algebra Exam, or a score
of at least 26 on the math component of the ACT exam, or a score of at least 600 on
the math component of the old SAT or 620 on the math component of the new SAT.
This course is equivalent to MATH 2053.

MATH 2183. Mathematical Reasoning in a Quantitative World. 3 Hours.
Mathematical and statistical reasoning are required in contexts of growing
complexity and sophistication. The purpose of this course is to cause students
to possess the power and habit of mind to search out quantitative information,
critique it, reflect upon it, and apply it in their public, personal and professional lives.
Prerequisite: MATH 1203, MATH 1204, or MATH 1313, or a score of at least 80%
on the University of Arkansas Mastery of Algebra Exam, or a score of at least 26
on the math component of the ACT exam, or a score of at least 600 on the math
component of the old SAT or 620 on the math component of the new SAT.

MATH 2213. Survey of Mathematical Structures I. 3 Hours.
Sets and logic, systems of numerations, number systems and operations,
and elementary number theory. Prerequisite: A grade of C or better in any of
MATH 1203, MATH 1204, MATH 1213, MATH 1284C, MATH 2033, MATH 2043,
MATH 2053, MATH 2183 or MATH 2554, or a score of at least 80% on the
University of Arkansas Mastery of Algebra Exam, or a score of at least 26 on
the math component of the ACT exam, or a score of at least 600 on the math
component of the old SAT or 620 on the math component of the new SAT.

MATH 2223. Survey of Mathematical Structures II. 3 Hours.
Geometry and measurement, and statistics and probability. Prerequisite: A grade of
C or better in MATH 2213.

MATH 2445. Calculus I with Review. 5 Hours.
Derivative of functions of one variable, applications of the derivative, introduction of
the integral, and applications. Credit will be allowed for only one of MATH 2445,
MATH 2554 or MATH 2043. Prerequisite: MATH 1213 with a grade of C or better, or
MATH 1284C with a grade of C or better, or a score of at least 70% on the University of
Arkansas Preparedness for Calculus Exam, or a score of at least 26 on the math component
of the old SAT or 660 on the math component of the ACT exam, or a score of at least 640 on the math component of the old SAT or 660 on the math component of the new SAT, or a score of at least 2 on the Calculus AB or BC Advanced Placement Exam.
This course is equivalent to MATH 2554.

MATH 2554. Calculus I (ACTS Equivalency = MATH 2405). 4 Hours.
Derivative of functions of one variable, applications of the derivative, introduction of
the integral, and applications. Credit will be allowed for only one of MATH 2554 and
MATH 2043. Prerequisite: MATH 1213 with a grade of C or better, or MATH 1284C
with a grade of C or better, or a score of at least 80% on the University of Arkansas
Preparedness for Calculus Exam, or a score of at least 28 on the math component of
the ACT exam, or a score of at least 640 on the math component of the old SAT or
660 on the math component of the new SAT, or a score of at least 2 on the Calculus AB or BC Advanced Placement Exam.

MATH 2554C. Calculus I (ACTS Equivalency = MATH 2405). 4 Hours.
Derivative of functions of one variable, applications of the derivative, introduction of
the integral, and applications. Credit will be allowed for only one of MATH 2554 and
MATH 2043. Corequisite: Drill component. Prerequisite: MATH 1213 with a grade of
C or better, or MATH 1284C with a grade of C or better, or a score of at least 80%
on the University of Arkansas Preparedness for Calculus Exam, or a score of at
least 28 on the math component of the ACT exam, or a score of at least 640 on the math
component of the old SAT or 660 on the math component of the new SAT, or a score
of at least 2 on the Calculus AB or BC Advanced Placement Exam.
This course is equivalent to MATH 2554.

MATH 2554H. Honors Calculus I. 4 Hours.
Topics in analytic geometry and calculus presented in a rigorous manner suitable for
an honors student. Students may not receive credit for both MATH 2043 and
MATH 2554. Prerequisite: Honors standing or departmental consent; and a score of
at least 30 on the math component of the ACT exam, or a score of at least 680 on the
math component of the old SAT or 710 on the math component of the new SAT.
This course is equivalent to MATH 2554.

MATH 2564. Calculus II (ACTS Equivalency = MATH 2505). 4 Hours.
Integral calculus of one variable and infinite series. Prerequisite: MATH 2554 with a
grade of C or better.

MATH 2564C. Calculus II. 4 Hours.
Integral calculus of one variable and infinite series. Three hours of lecture and
two hours of drill (recitation) per week. Corequisite: Drill component. Prerequisite:
MATH 2554 with a grade of C or better.
This course is equivalent to MATH 2564.

MATH 2564H. Honors Calculus II. 4 Hours.
Integral calculus of one variable and infinite series. Prerequisite: MATH 2554 with a
grade of A, or MATH 2554H with a grade of A or B, or a score of 5 on the AP AB
Calculus Exam.
This course is equivalent to MATH 2564.

MATH 2574. Calculus III (ACTS Equivalency = MATH 2603). 4 Hours.
Differential and integral calculus of several variables, and vector calculus.
Prerequisite: MATH 2554 with a grade of C or better.

MATH 2574C. Calculus III. 4 Hours.
Differential and integral calculus of several variables, and vector calculus. Three
hours of lecture and two hours of drill (recitation) per week. Corequisite: Drill
component. Prerequisite: MATH 2554 with a grade of C or better.
This course is equivalent to MATH 2574.

MATH 2574H. Honors Calculus III. 4 Hours.
Differential and integral calculus of several variables, and vector calculus.
Prerequisite: MATH 2554 with a grade of A, or MATH 2564H with a grade of A or B,
or a score of 5 on the AP BC Calculus exam.
This course is equivalent to MATH 2574.

MATH 2584. Elementary Differential Equations. 4 Hours.
First and second order ordinary differential equations, the Laplace transform, and
matrix systems of ordinary differential equations. Prerequisite: MATH 2564 or
MATH 2564C with a grade of C or better.
MATH 2584C. Elementary Differential Equations. 4 Hours.
First and second order ordinary differential equations, the Laplace transform, and
matrix systems of ordinary differential equations. Three hours of lecture and two
hours of drill (recitation) per week. Corequisite: MATH 2564 or MATH 2564C with a grade C or better.
This course is equivalent to MATH 2584.
MATH 2584H. Honors Elementary Differential Equations. 4 Hours.
Topics in ordinary differential equations, systems of differential equations and
the Laplace transform presented with an emphasis on modeling. Prerequisite:
MATH 2564 with a grade of A, or MATH 2564H with a grade of A or B, or a score of
5 on the AP BC Calculus exam.
This course is equivalent to MATH 2584.
MATH 2603. Discrete Mathematics. 3 Hours.
Introductory study of sets, relations, logic, proofs, algorithms, counting methods,
graph theory, trees, and Boolean algebras. Prerequisite: MATH 2554 with a grade of
C or better or the equivalent.
MATH 2603C. Discrete Mathematics. 3 Hours.
Introductory study of sets, relations, logic, proofs, algorithms, counting methods,
graph theory, trees, and Boolean algebras. Corequisite: Drill component.
Prerequisite: MATH 2554 with a grade of C or better or the equivalent.
This course is equivalent to MATH 2603.
MATH 2701. Survey of Higher Math. 1 Hour.
This course overviews the landscape of higher mathematics, touching on many of
the themes of modern mathematics: proof, logic, cardinality, analysis, modeling,
abstract algebra, number theory, topology and geometry. Pre- or Corequisite:
MATH 2564.
MATH 2803. Transition to Advanced Mathematics. 3 Hours.
An introduction to concepts encountered in advanced mathematics. Emphasis is
placed on developing the student's problem solving skills and ability to correctly communicate abstract concepts. Topics to include set theory, logic, relations,
functions and mathematical induction presented in the context of intriguing mathematical problems. Pre- or Corequisite: MATH 2554 or MATH 2554C.
MATH 2903. Functions, Foundations and Models. 3 Hours.
An in-depth study of topics from secondary school mathematics, emphasizing the
development of the concept function, function patterns in data sets, connections
among the main topics associated with a secondary school curriculum, and the
appropriate use of technology. Pre-or Corequisite: MATH 2564 or MATH 2564C.
MATH 3013. Introduction to Probability. 3 Hours.
A calculus-based introduction to probability. Discrete probability spaces and
counting techniques, discrete and continuous probability distributions, random
variables, random samples, law of large numbers, central limit theorem. Prerequisite:
MATH 2564 or MATH 2564C.
This course is cross-listed with STAT 3013.
MATH 3083. Linear Algebra. 3 Hours.
Systems of linear equations, vector spaces, linear transformations, matrices,
and determinants. Only one of MATH 3083 and MATH 3093 will count for credit.
Prerequisite: MATH 2554 or MATH 2043, with a grade of C or better.
MATH 3093. Abstract Linear Algebra. 3 Hours.
A proof-based course on vector spaces, linear transformations, matrices,
determinants, eigenspaces and eigenvalues, with applications. Recommended for
mathematics majors. Only one of MATH 3083 and MATH 3093 may be counted for credit. Pre- or Corequisite: MATH 2564 with a C or better. Prerequisite: MATH 2803 with a C or better.
MATH 3103. Combinatorial and Discrete Mathematics. 3 Hours.
Basic combinatorial techniques including the study of networks, generating
functions, principles of inclusion/ exclusion, Zn, Hamming coding theory, graph
theory, and block designs. Prerequisite: MATH 2603 or MATH 2803.
MATH 3113. Introduction to Abstract Algebra I. 3 Hours.
Introduction to algebraic structures with emphasis on rigorous justification of results. Prerequisite: MATH 2803 with a grade of C or better; and MATH 3083 or MATH 3093 with a grade of C or better.
MATH 3133. History of Mathematics. 3 Hours.
Survey of the development of mathematical ideas from the ancient to the modern
times. Prerequisite: MATH 2554, and MATH 2603 or MATH 2803, both with a grade
of C or better.
MATH 3203. Number Theory. 3 Hours.
Topics in elementary number theory. Prerequisite: MATH 2554, and MATH 2603 or
MATH 2803, both with a grade of C or better.
MATH 3513. Elementary Analysis. 3 Hours.
A first rigorous course in analysis. The formal basis of the real number system,
sequences and series, the Bolzano-Weierstrass Theorem, limits and continuity,
the Intermediate Value Theorem, Rolle's Theorem, differentiation, the Mean
Value Theorem and its consequences, Taylor's Theorem, L'Hôpital's rules,
convexity, Riemann integration, the Fundamental Theorem of Calculus. Only one
of MATH 3513 and MATH 4513 may be counted for credit toward the major.
Prerequisite: A grade of C or better in each of MATH 2554 or MATH 2554C,
MATH 2564 or MATH 2564C, MATH 2574 or MATH 2574C, MATH 3083 or
MATH 3093, and MATH 2803.
MATH 3773. Foundations of Geometry I. 3 Hours.
Axiomatic method; Euclidean geometry; non-Euclidean geometry. Prerequisite:
MATH 2554, and MATH 2603 or MATH 2803, each with a grade of C or better.
MATH 3923H. Honors Colloquium. 3 Hours.
Covers a special topic or issue, offered as part of the honors program. Prerequisite:
Honors candidacy (not restricted to candidacy in mathematics). May be repeated for
degree credit.
MATH 399VH. Honors Mathematics Course. 1-6 Hour.
Honors mathematics course. Prerequisite: Departmental consent. May be repeated for up to 12 hours of degree credit.
MATH 400V. Directed Readings. 1-7 Hour.
Directed readings. Prerequisite: Departmental consent. May be repeated for up to 7
hours of degree credit.
MATH 404V. Classroom Practices in Mathematics. 1-3 Hour.
The pedagogy of curricular materials in mathematics acquired through participation
in the classroom as an apprentice teacher. Non-major elective credit only.
Prerequisite: MATH 2574 and departmental approval.
MATH 405V. Internship in Professional Practice. 1-3 Hour.
Professional work experience involving significant use of mathematics or statistics
in business, industry or government. Prerequisite: Departmental consent. May be repeated for up to 3 hours of degree credit.
MATH 4103. Advanced Linear Algebra. 3 Hours.
Linear functionals, matrix representation of linear transformations, scalar product,
and spectral representation of linear transformations. Prerequisite: MATH 3083 or
MATH 3093.
MATH 4113. Introduction to Abstract Algebra II. 3 Hours.
Topics in abstract algebra including finite abelian groups, linear groups, factorization
in commutative rings and Galois theory. Prerequisite: MATH 3113.
MATH 4153. Mathematical Modeling. 3 Hours.
Mathematical techniques for formulating, analyzing, and criticizing deterministic
models taken from the biological, social, and physical sciences. Techniques include
graphical methods, stability, optimization, and phase plane analysis. Prerequisite:
MATH 2584.
MATH 4163. Dynamic Models in Biology. 3 Hours.
Mathematical and computational techniques for developing, executing, and analyzing dynamic models arising in the biological sciences. Both discrete and continuous time models are studied. Applications include population dynamics, cellular dynamics, and the spread of infectious diseases. Prerequisite: MATH 2554. This course is cross-listed with BIOL 4163.

MATH 4173. Mathematical CAM Design. 3 Hours.
Mathematical and computational techniques for Computer aided manufacturing. Applying linear algebra to model 3d space, representation of curves and surfaces in 3d models, converting between smooth and discrete approximations of curves, algorithms to create surfaces from machine toolpaths, inverse kinematics, basic G-Code programming. Prerequisite: MATH 2574 or MATH 2574C.

MATH 4253. Symbolic Logic I. 3 Hours.
Rigorous analyses of the concepts of proof, consistency, equivalence, validity, implication, and truth. Full coverage of truth-functional logic and quantification theory (predicate calculus). Discussion of the nature and limits of mechanical procedures (algorithms) for proving theorems in logic and mathematics. Informal accounts of the basic facts about infinite sets. Prerequisite: MATH 2603, MATH 2803, or PHIL 2203. This course is cross-listed with PHIL 4253.

MATH 4303. Ordinary Differential Equations. 3 Hours.
Existence, uniqueness, stability, qualitative behavior, and numerical solutions. Prerequisite: MATH 2584 and (MATH 4513 or MATH 3513).

MATH 4353. Numerical Linear Algebra. 3 Hours.
Numerical methods for problems of linear algebra, including the solution of very large systems, eigenvalues, and eigenvectors. Prerequisite: MATH 3083 or MATH 3093.

MATH 4363. Numerical Analysis. 3 Hours.
General iterative techniques, error analysis, root finding, interpolation, approximation, numerical integration, and numerical solution of differential equations. Prerequisite: MATH 2584.

MATH 4423. Introduction to Partial Differential Equations. 3 Hours.
Matrices, Fourier analysis, and partial differential equations. Prerequisite: MATH 2584 or MATH 2584C with a grade of C or better.

MATH 4443. Complex Variables. 3 Hours.
Complex analysis, series, and conformal mapping. Additional applications for graduate credit. Prerequisite: MATH 2603 or MATH 2803, and MATH 2584 or MATH 2584C.

MATH 4503. Differential Geometry. 3 Hours.
Topics include: classical differential geometry of curves and surfaces in 3-space, differential forms and vector fields. Prerequisite: MATH 2574 or MATH 2574C.

MATH 4513. Advanced Calculus I. 3 Hours.
The real and complex number systems, basic set theory and topology, sequences and series, continuity, differentiation, and Taylor's theorem. Emphasis is placed on careful mathematical reasoning. Only one of MATH 3513 and MATH 4513 may be counted for credit toward the major. Prerequisite: MATH 2574, MATH 2803 and MATH 3083 or MATH 3093.

MATH 4523. Advanced Calculus II. 3 Hours.
The Riemann-Stieltjes integral, uniform convergence of functions, Fourier series, implicit function theorem, Jacobians, and derivatives of higher order. Prerequisite: MATH 4513.

MATH 4703. Introduction to Point-Set Topology. 3 Hours.
A study of topological spaces including continuous transformations, connectedness and compactness. Prerequisite: MATH 4513.

MATH 4933. Mathematics Major Seminar. 3 Hours.
Weekly seminars on topics of historical or cross-disciplinary interest, designed to address students' mathematical knowledge, problem-solving and communication skills, in which student presentations play a part. Also serves as a forum for sharing information about career opportunities and preparation for employment. Prerequisite: Senior standing and a mathematics major, or departmental consent.

MATH 498V. Senior Thesis. 1-6 Hour.
Senior thesis.

MATH 499V. Research Topics in Mathematics. 1-3 Hour.
Current research interests in mathematics, at an advanced undergraduate or beginning graduate level. Prerequisite: Departmental consent. May be repeated for up to 12 hours of degree credit.

MATH 499VH. Honors Research Topics in Mathematics. 1-3 Hour.
Current research interests in mathematics, at an advanced undergraduate or beginning graduate level. Prerequisite: Departmental consent. May be repeated for up to 12 hours of degree credit. This course is equivalent to MATH 499V.

MATH 5001. Connections to School Mathematics. 1 Hour.
This course is a supplement to any graduate course in statistics, algebra, analysis, or geometry. The purpose is to connect the content of the graduate course to school mathematics. Prerequisite: Departmental consent. May be repeated for up to 6 hours of degree credit.

MATH 5013. Abstract Algebra with Connections to School Mathematics. 3 Hours.
Basic structures of abstract algebra (rings, fields, groups, modules and vector spaces) with emphasis on rings and fields as generalizations of the ring of integers and field of rational numbers. Degree credit will not be awarded for both MATH 4113 (or MATH 5123) plus MATH 5001 and for MATH 5013. Prerequisite: Graduate standing or departmental consent.

MATH 5023. Geometry with Connections to School Mathematics. 3 Hours.
School geometry from an advanced perspective including conformity to the Common Core State Standards for Mathematics. Study will include historical developments and geometry based on transformations of two- and three-dimensional space. Prerequisite: Graduate standing.

MATH 5033. Advanced Calculus with Connections to School Mathematics Teaching. 3 Hours.
Rigorous development of the real numbers, continuity, differentiation, and integration. Degree credit will not be awarded for both MATH 4513 (or MATH 5503) plus MATH 5001 and for MATH 5033. Prerequisite: Departmental consent.

MATH 504V. Special Topics for Teachers. 1-6 Hour.
Current topics in mathematics of interest to secondary school teachers. Prerequisite: Graduate standing or departmental consent. May be repeated for degree credit.

MATH 5053. Probability & Statistics with Connections to School Mathematics. 3 Hours.
The content is guided by the high school probability and statistics. The purpose is to connect the content of the graduate course to school mathematics. Prerequisite: Departmental consent. May be repeated for up to 6 hours of degree credit.

MATH 506V. Professional Development for Secondary Mathematics Teaching. 1-6 Hour.
Validated participation in professional development mathematics workshops or institutes sanctioned by national or international educational organizations such as the College Board, International Baccalaureate Program, and the National Board for Professional Teaching Standards. Prerequisite: Enrollment in Secondary Mathematics Teaching, MA degree program or departmental consent. May be repeated for up to 6 hours of degree credit.
MATH 510V. Mathematical Seminar. 1-3 Hour.
Members of the faculty and advanced students meet for presentation and
discussion of topics. Prerequisite: Graduate standing in mathematics or statistics, or
departmental consent. May be repeated for up to 3 hours of degree credit.

MATH 5123. Algebra I. 3 Hours.
What the beginning graduate student should know about algebra: groups, rings,
fields, modules, algebras, categories, homological algebra, and Galois Theory.
Prerequisite: MATH 3113, and graduate standing in mathematics or statistics, or
departmental consent.

MATH 5133. Algebra II. 3 Hours.
Continuation of MATH 5123. Prerequisite: MATH 5123, and graduate standing in
mathematics or statistics.

MATH 5153. Advanced Linear Algebra. 3 Hours.
(Formerly MATH 4103.) Linear functionals, matrix representation of linear
transformations, scalar product, and spectral representation of linear
transformations. Graduate degree credit will not be given for both MATH 4103 and
MATH 5153. Prerequisite: Graduate standing.

MATH 5213. Advanced Calculus I. 3 Hours.
(Formerly MATH 4513.) The real and complex number systems, basic set theory and
topology, sequences and series, continuity, differentiation, and Taylor's theorem.
Emphasis is placed on careful mathematical reasoning. Graduate degree credit
will not be given for both MATH 4513 and MATH 5213. Prerequisite: Graduate standing.

MATH 5223. Advanced Calculus II. 3 Hours.
(Formerly MATH 4523.) The Riemann-Stieljes integral, uniform convergence of
functions, Fourier series, implicit function theorem, Jacobians, and derivatives of
higher order. Graduate degree credit will not be given for both MATH 4523 and
MATH 5223. Prerequisite: MATH 4513 or MATH 5213 (formerly MATH 4513).

MATH 5303. Ordinary Differential Equations. 3 Hours.
Existence, uniqueness, stability, qualitative behavior, and numerical solutions.
Prerequisite: MATH 2584 and MATH 4513, and graduate standing in mathematics or
statistics, or departmental consent.

MATH 5313. Partial Differential Equations. 3 Hours.
Laplace's equation, Heat equation, Wave Equation, Method of Characteristics.
Prerequisite: MATH 4423, MATH 4513, and graduate standing in mathematics or
statistics, or departmental consent.

MATH 5323. Partial Differential Equations II. 3 Hours.
Fourier Transforms, Sobolev Spaces, Elliptic Regularity. Prerequisite: MATH 5313,
and graduate standing in mathematics or statistics, or departmental consent.

MATH 5363. Scientific Computation and Numerical Methods. 3 Hours.
An introduction to numerical methods used in solving various problems in
engineering and the sciences. May not earn credit for this course and MATH 4353
or MATH 4363. Prerequisite: Graduate standing in mathematics or statistics, or
departmental consent.
This course is cross-listed with PHYS 5363.

MATH 5383. Numerical Analysis. 3 Hours.
(Formerly MATH 4363.) General iterative techniques, error analysis, root finding,
interpolation, approximation, numerical integration, and numerical solution of
differential equations. Graduate degree credit will not be given for both MATH 4363
and MATH 5383. Prerequisite: Graduate standing.

MATH 5393. Numerical Linear Algebra. 3 Hours.
(Formerly MATH 4353.) Numerical methods for problems of linear algebra, including
the solution of very large systems, eigenvalues, and eigenvectors. Graduate degree
credit will not be given for both MATH 4353 and MATH 5393. Prerequisite: Graduate standing.

MATH 5423. Introduction to Partial Differential Equations. 3 Hours.
Matrices, Fourier analysis, and partial differential equations. Does not count towards
degree credit in MATH. Prerequisite: Graduate standing.

MATH 5453. Functional Analysis I. 3 Hours.
Banach Spaces, Hilbert Spaces, operator theory, compact operators, dual
spaces and adjoints, spectral theory, Hahn-Banach, open mapping and closed
graph theorems, uniform boundedness principle, weak topologies. Prerequisite:
MATH 5513, and graduate standing in mathematics or statistics, or departmental
consent.

MATH 5503. Theory of Functions of a Real Variable I. 3 Hours.
Real number system, Lebesque measure, Lebesque integral, convergence
theorems, differentiation of monotone functions, absolute continuity and the
fundamental theorem of calculus L^P spaces, Holder and Minkowski inequalities,
and bounded linear functionals on the L^P spaces. Prerequisite: MATH 4523 or
MATH 5223 (formerly MATH 4523), and graduate standing in mathematics or
statistics, or departmental consent.

MATH 5513. Theory of Functions of a Real Variable II. 3 Hours.
Measure and integration on abstract measure spaces, signed measures, Hahn
decomposition, Radon-Nikodym theorem, Lebesque decomposition, measures
on algebras and their extensions, product measures, and Fubini's theorem.
Prerequisite: MATH 5503, and graduate standing in mathematics or statistics, or
departmental consent.

MATH 5523. Theory of Functions of a Complex Variable I. 3 Hours.
Complex numbers, analytic functions, power series, complex integration, Cauchy's
Theorem and integral formula, maximum principle, singularities, Laurent series, and
Mobius maps. Prerequisite: MATH 4513 or MATH 5213 (formerly MATH 4513).

MATH 5533. Theory of Functions of a Complex Variable II. 3 Hours.
Riemann Mapping Theorem, analytic continuation, harmonic functions, and entire
functions. Prerequisite: MATH 5523, and graduate standing in mathematics or
statistics, or departmental consent.

MATH 5703. Topology I. 3 Hours.
An introduction to topology. Topics include metric spaces, topological spaces and
general point-set topology, homotopy and the fundamental group, covering spaces,
the classification of surfaces. Prerequisite: MATH 4513 or MATH 5213 (formerly
MATH 4513), and graduate standing in mathematics or statistics, or departmental
consent.

MATH 5713. Topology II. 3 Hours.
The continuation of Topology I. Topics include: advanced homotopy and covering
spaces, the Seifert-van Kampen theorem, homology and the Mayer-Vietoris
sequence. Prerequisite: MATH 5703, and graduate standing in mathematics or
statistics, or departmental consent.

MATH 5723. Differential Topology I. 3 Hours.
An introduction to the topology of smooth manifolds: applications of the inverse
function theorem to smooth maps, Sard's theorem, transversality, intersection
theory, degrees of maps, vector fields and differential forms on manifolds, integration
on manifolds. Prerequisite: MATH 4513 or MATH 5213 (formerly MATH 4513) and
graduate standing in mathematics or statistics, or departmental consent.

MATH 5733. Differential Topology II. 3 Hours.
The continuation of Differential Topology I, with additional advanced topics. Possible
advanced topics may include: Morse theory, de Rham cohomology theory, Poincare
duality, Riemannian geometry, and Lie groups and Lie algebras. Prerequisite:
MATH 5723 and graduate standing in mathematics or statistics, or departmental
consent.

MATH 609V. Topics in Math Education. 1-6 Hour.
Topics in mathematics education research including curriculum, teacher education,
learning theory, and assessment. Prerequisite: Graduate standing. May be repeated
for up to 12 hours of degree credit.

MATH 610V. Directed Readings. 1-6 Hour.
Directed readings. Prerequisite: Departmental consent.
MATH 619V. Topics in Algebra. 1-6 Hour.
Current research interests in algebra. Prerequisite: Graduate standing in mathematics or statistics, or departmental consent. May be repeated for degree credit.

MATH 6203. Theory of Probability. 3 Hours.
A rigorous mathematical treatment based on measure theory of the fundamental notions and results of the theory of probability. Topics covered include laws of large numbers, central limit theorems, conditional expectations. Additional topics that may be covered include martingales, Markov chains, Brownian motion and stochastic integration. Prerequisite: MATH 5513.

MATH 6213. Mathematical Statistics. 3 Hours.
A rigorous mathematical treatment of the fundamental principles and results in the theory of Statistics. Topics include exponential families of distributions, estimation of unknown parameters, the classical theory of hypothesis testing, Large sample approximations, large sample properties of estimators. Prerequisite: MATH 6203.

MATH 659V. Topics in Analysis. 1-6 Hour.
Current research interests in analysis. Prerequisite: Graduate standing in mathematics or statistics, or departmental consent. May be repeated for degree credit.

MATH 679V. Topics in Topology. 1-6 Hour.
Current research interest in topology. Prerequisite: Graduate standing in mathematics or statistics, or departmental consent. May be repeated for degree credit.

MATH 700V. Doctoral Dissertation. 1-18 Hour.
Doctoral Dissertation. Prerequisite: Doctoral candidacy in mathematics. May be repeated for degree credit.