Mathematics (MATH)

Courses

MATH 00101. College Algebra Laboratory I. 1 Hour.
This course provides additional support and instruction for students enrolled in MATH 11003 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. (Typically offered: Fall, Spring and Summer)

MATH 00202. College Algebra Laboratory II. 2 Hours.
This course provides additional support and instruction for students enrolled in MATH 11003 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. (Typically offered: Fall, Spring and Summer)

MATH 01101. Quantitative Reasoning Laboratory. 1 Hour.
This course provides additional support and instruction for students enrolled in MATH 11103 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. (Typically offered: Fall, Spring and Summer)

MATH 11003. 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 46 on ALEKS, at least 22 on the math component of the ACT exam, at least 540 on the math component of the new SAT or old SAT, at least 63 on the Accuplacer Classic College Math, at least 263 on the Accuplacer Next Generation QAS, at least 254 on the Accuplacer NG AAF, or at least 66 on the Compass Algebra. Students who score at least 30 on ALEKS, at least 19 on the math component of the ACT exam, at least 510 on the math component of the new SAT or 460 on the math component of the old SAT, at least 42 on the Accuplacer Classic College Math, at least 255 on the Accuplacer Next Generation QAS, at least 235 on the Accuplacer NG AAF, or at least 41 on the Compass Algebra must also register for MATH 00101 as a corequisite. Students who score below 30 on ALEKS, below 19 on the math component of the ACT exam, below 510 on the math component of the new SAT or 460 on the math component of the old SAT, below 42 on the Accuplacer Classic College Math, below 255 on the Accuplacer Next Generation QAS, below 235 on the Accuplacer NG AAF, or below 41 on the Compass Algebra must also register for MATH 00202 as a corequisite. (Typically offered: Fall, Spring and Summer)

MATH 11103. 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 40 on ALEKS, at least 19 on the ACT exam, at least 510 on the math component of the newSAT, at least 460 on the math component of the old SAT, at least 42 on the Accuplacer Classic College Math, at least 255 on the Accuplacer Next Generation QAS, at least 235 on the Accuplacer Next Generation AAF, or at least 41 on Compass Algebra. Students who score below 40 on ALEKS, below 19 on the math component of the ACT exam, below 510 on the math component of the new SAT, below 460 on the math component of the old SAT, below 42 on the Accuplacer Classic College Math, below 255 on the Accuplacer Next Generation QAS, below 235 on the Accuplacer Next Generation AAF, or below 41 on Compass Algebra must also register for MATH 01101 as a corequisite. (Typically offered: Fall and Spring)

MATH 12003. 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 12003 or MATH 13004. Prerequisite: MATH 11003 with a grade of C or better, or a score of at least 60 on the Math Placement Test, 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. (Typically offered: Fall, Spring and Summer)

MATH 13004. Precalculus Mathematics (ACTS Equivalency = MATH 1305). 4 Hours.
Topics in algebra and trigonometry. To be taken by students who expect to take MATH 24004. Corequisite: Drill component. Prerequisite: MATH 11003 with a grade of C or better, or a score of at least 60 on the Math Placement Test, 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. (Typically offered: Fall, Spring and Summer)

MATH 15104. 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 25104; these two courses together are equivalent to MATH 13004 and MATH 24004. MATH 15104 BY ITSELF NOT EQUIVALENT TO EITHER Math 1284C OR Math 2554C. This course must be taken with MATH 25104. Intended for students who place into MATH 13004, but who would profit from an earlier exposure to calculus concepts. Closed to students with credit for MATH 24004. Prerequisite: MATH 11003 with a grade of C or better, or a score of at least 60 on the Math Placement Test, 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. (Typically offered: Fall)

MATH 20503. 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 11003 or MATH 11103 or MATH 12003 or MATH 13004 or MATH 22003) each with a grade of C or better, or a score of at least 60 on the Math Placement Test, 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. (Typically offered: Fall, Spring and Summer)

MATH 21003. Principles of Statistics (ACTS Equivalency = MATH 2103). 3 Hours.
A problem-oriented course with applications from many fields. Emphasis on understanding the nature of statistical orderliness implied by probability laws. Statistical analysis is treated as a means of decision making in the face of uncertainty. Prerequisite: MATH 11003 with a grade of C or better, or MATH 11103 with a grade of C or better, or a score of at least 50 on the Math Placement Test, 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. (Typically offered: Fall, Spring and Summer)

MATH 21803. 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 11003, or MATH 11103, or a score of at least 60 on the Math Placement Test, 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. (Typically offered: Fall and Spring)

MATH 22003. 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 22003 and MATH 24004. Prerequisite: MATH 11003 or MATH 12003 or MATH 13004 or MATH 20503 with a grade of C or better, or a score of at least 60 on the Math Placement Test, 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. (Typically offered: Fall, Spring and Summer)

MATH 22103. 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 11003, MATH 12003, MATH 13004, MATH 11103, MATH 22003, MATH 20503, MATH 21803 or MATH 24004, 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. (Typically offered: Fall, Spring and Summer)

MATH 22203. Survey of Mathematical Structures II. 3 Hours.
Geometry and measurement, and statistics and probability. Prerequisite: A grade of C or better in MATH 22103. (Typically offered: Fall, Spring and Summer)

MATH 24004. 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 24004 and MATH 22003. Corequisite: Drill component. Prerequisite: MATH 12003 with a grade of C or better, or MATH 13004 with a grade of C or better, or a score of at least 76 on the Math Placement Test, 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. (Typically offered: Fall, Spring and Summer)

MATH 24005. Calculus I with Review (ACTS Equivalency = MATH 2405). 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 24005, MATH 24004 or MATH 22003. Prerequisite: MATH 12003 with a grade of C or better, or MATH 13004 with a grade of C or better, or a score of at least 70 on the Math Placement Test, 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. (Typically offered: Fall, Spring and Summer)
This course is equivalent to MATH 24004.

MATH 240H4. 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 22003 and MATH 24004. Corequisite: Drill component. 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. (Typically offered: Fall and Spring)
This course is equivalent to MATH 24004.

MATH 25004. 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 24004 with a grade of C or better. (Typically offered: Fall, Spring and Summer)

MATH 250H4. Honors Calculus II. 4 Hours.
Integral calculus of one variable and infinite series. Corequisite: Drill component. Prerequisite: MATH 24004 with a grade of A, or MATH 240H4 with a grade of A or B, or a score of 5 on the AP AB Calculus Exam. (Typically offered: Spring)
This course is equivalent to MATH 25004.

MATH 25104. Calculus with Algebra and Trigonometry II. 4 Hours.
Continuation of MATH 15104. Topics in algebra, trigonometry and precalculus are integrated with elementary differential and integral calculus. Completion of MATH 15104 and MATH 25104 is equivalent to completion of MATH 13004 and MATH 24004. This course is meant exclusively for students who have previously taken MATH 15104. MATH 25104 BY ITSELF NOT EQUIVALENT TO EITHER MATH 13004 OR MATH 24004. Closed to students with credit for MATH 24004. Prerequisite: MATH 15104 with a grade of C or better. (Typically offered: Spring)

MATH 25804. 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: Drill component. Prerequisite: MATH 25004 with a grade C or better. (Typically offered: Fall, Spring and Summer)

MATH 258H4. 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. Corequisite: Drill component. Prerequisite: MATH 25004 with a grade of A, or MATH 250H4 with a grade of A or B, or a score of 5 on the AP BC Calculus exam. (Typically offered: Irregular)
This course is equivalent to MATH 25804.

MATH 26004. 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 25004 with a grade of C or better. (Typically offered: Fall, Spring and Summer)

MATH 260H4. Honors Calculus III. 4 Hours.
Differential and integral calculus of several variables, and vector calculus. Corequisite: Drill Component. Prerequisite: MATH 25004 with a grade of A, or MATH 250H4 with a grade of A or B, or a score of 5 on the AP BC Calculus exam. (Typically offered: Fall and Spring)
This course is equivalent to MATH 26004.

MATH 26103. Discrete Mathematics. 3 Hours.
Introductory study of sets, relations, logic, proofs, algorithms, counting methods, graph theory, trees, and Boolean algebras. Prerequisite: MATH 24004 with a grade of C or better or the equivalent. (Typically offered: Fall, Spring and Summer)

MATH 28001. Transition to Advanced Mathematics Laboratory. 1 Hour.
Introduction to mathematical software and application to career opportunities in mathematics. Pre- or corequisite: MATH 28003. (Typically offered: Fall and Spring)

MATH 28003. 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 24004. (Typically offered: Fall and Spring)

MATH 29003. 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 25004. (Typically offered: Fall and Spring)

MATH 30103. 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 25004. (Typically offered: Fall, Spring and Summer)
This course is cross-listed with STAT 30133.

MATH 30803. Linear Algebra. 3 Hours.
Systems of linear equations, vector spaces, linear transformations, matrices, and determinants. Only one of MATH 30803 and MATH 30903 will count for credit. Prerequisite: MATH 24004 or MATH 22003, with a grade of C or better. (Typically offered: Fall, Spring and Summer)

MATH 30903. 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 30803 and MATH 30903 may be counted for credit. Pre- or Corequisite: MATH 25004 with a C or better. Prerequisite: MATH 28003 with a C or better. (Typically offered: Fall and Spring)

MATH 31003. Combinatorics. 3 Hours.
Basic combinatorial techniques including the study of the principle of inclusion and exclusion and generating functions. Additional topics may include modular arithmetic, algebraic coding theory, Polya's method of enumeration, and an introduction to abstract algebraic structures. Prerequisite: MATH 26103 or MATH 28003. Pre- or Corequisite: MATH 30803 or MATH 30903. (Typically offered: Fall and Spring)

MATH 31103. Introduction to Abstract Algebra I. 3 Hours.
Introduction to algebraic structures with emphasis on rigorous justification of results. Prerequisite: MATH 28003 with a grade of C or better; and MATH 30803 or MATH 30903 with a grade of C or better. (Typically offered: Fall and Spring)

MATH 31303. History of Mathematics. 3 Hours.
Survey of the development of mathematical ideas from the ancient to the modern times. Prerequisite: MATH 24004, and MATH 26103 or MATH 28003, both with a grade of C or better. (Typically offered: Spring)

MATH 32003. Number Theory. 3 Hours.
Topics in elementary number theory. Prerequisite: MATH 24004, and MATH 26103 or MATH 28003, both with a grade of C or better. (Typically offered: Irregular)

MATH 35103. 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'Hopital's rules, convexity, Riemann integration, the Fundamental Theorem of Calculus. Only one of MATH 35103 and MATH 45103 may be counted for credit toward the major. Prerequisite: A grade of C or better in each of MATH 24004, MATH 25004, MATH 26004, MATH 30803 or MATH 30903, and MATH 28003. (Typically offered: Fall)

MATH 35803. Foundations of Applied Mathematics. 3 Hours.
Introduction to the derivation and analysis of physical models. Topics include dimensional analysis, perturbation methods, the method of characteristics, continuum mechanics, and elastic, material and fluid equations. Case studies come from biology, fluid dynamics, engineering, chemistry and other areas. Prerequisite: MATH 26004 and MATH 25804. (Typically offered: Fall)

MATH 37703. Foundations of Geometry I. 3 Hours.
Axiomatic method; Euclidean geometry; non-Euclidean geometry. Prerequisite: MATH 24004, and MATH 26103 or MATH 28003, each with a grade of C or better. (Typically offered: Fall)

MATH 399HV. Honors Mathematics Course. 1-6 Hour.
Honors thesis research and writing under the direction of a faculty member in the department. Prerequisite: Departmental consent. (Typically offered: Fall, Spring and Summer) May be repeated for up to 12 hours of degree credit.

MATH 4000V. Directed Readings. 1-7 Hour.
Directed readings. Prerequisite: Departmental consent. (Typically offered: Fall, Spring and Summer) May be repeated for up to 7 hours of degree credit.

MATH 4050V. 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. (Typically offered: Fall, Spring and Summer) May be repeated for up to 3 hours of degree credit.

MATH 41003. Advanced Linear Algebra. 3 Hours.
Linear functionals, matrix representation of linear transformations, scalar product, and spectral representation of linear transformations. Prerequisite: MATH 30803 or MATH 30903. (Typically offered: Irregular)

MATH 41103. 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 31103. (Typically offered: Spring)

MATH 41503. 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 25804. (Typically offered: Irregular)

MATH 41603. 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 24004. (Typically offered: Irregular)
This course is cross-listed with BIOL 41673.

MATH 42503. 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 26103, MATH 28003, or PHIL 22003. (Typically offered: Fall)
This course is cross-listed with PHIL 42503.

MATH 43003. Ordinary Differential Equations. 3 Hours.
Existence, uniqueness, stability, qualitative behavior, and numerical solutions. Prerequisite: MATH 25804 and (MATH 45103 or MATH 35103). (Typically offered: Fall)

MATH 43403. Introduction to Scientific Computing. 3 Hours.
Provides an understanding of a diverse set of problems, as well as algorithms for solving them and implementing the algorithms using high performance computing resources and environments. The emphasis is on problem solving and offers multiple projects concerning applications in science and engineering. Prerequisite: MATH 30803 or MATH 30903. (Typically offered: Spring)

MATH 43503. Numerical Linear Algebra. 3 Hours.
Numerical methods for problems of linear algebra, including the solution of very large systems, eigenvalues, and eigenvectors. Prerequisite: MATH 30803 or MATH 30903. (Typically offered: Spring)

MATH 43603. Numerical Analysis. 3 Hours.
General iterative techniques, error analysis, root finding, interpolation, approximation, numerical integration, and numerical solution of differential equations. Prerequisite: MATH 25804. (Typically offered: Fall)

MATH 43703. Finite Element Methods and Solution of Sparse Linear Systems. 3 Hours.
Provides an in-depth understanding of numerical methods for the solution of partial differential equations using Finite Element Methods, Direct and Iterative Methods for the Sparse Linear Systems. Prerequisite: MATH 43503. (Typically offered: Spring)

MATH 44003. Numerical Linear Algebra II. 3 Hours.
Provides an in-depth understanding of numerical methods for the solution of large scale eigenvalue problems arising in science and engineering applications including theory, implementation and applications. Prerequisite: MATH 43503. (Typically offered: Fall)

MATH 44203. Introduction to Partial Differential Equations. 3 Hours.
Separation of variables, Fourier transform, and Laplace transform methods for the solution of partial differential equations. Topics include Fourier series, Fourier-Bessel series, orthogonal expansions, and the error function. Prerequisite: MATH 25804 with a grade of C or better; and MATH 26004 with a grade of C or better. (Typically offered: Fall, Spring and Summer)

MATH 44403. Complex Variables. 3 Hours.
Complex analysis, series, and conformal mapping. Additional applications for graduate credit. Prerequisite: MATH 26103 or MATH 28003, and MATH 25804. (Typically offered: Fall)

MATH 45003. Differential Geometry. 3 Hours.
Topics include: classical differential geometry of curves and surfaces in 3-space, differential forms and vector fields. Prerequisite: MATH 26004. (Typically offered: Irregular)

MATH 45103. 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 35103 and MATH 45103 may be counted for credit toward the major. Prerequisite: MATH 26004, MATH 28003 and MATH 30803 or MATH 30903. (Typically offered: Fall and Spring)

MATH 45203. 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 45103. (Typically offered: Spring)

MATH 47003. Introduction to Point-Set Topology. 3 Hours.
A study of topological spaces including continuous transformations, connectedness and compactness. Prerequisite: MATH 45103. (Typically offered: Irregular)

MATH 49303. 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. (Typically offered: Spring)

MATH 4980V. Senior Thesis. 1-6 Hour.
Senior thesis. (Typically offered: Fall, Spring and Summer)

MATH 4990V. Research Topics in Mathematics. 1-3 Hour.
Current research interests in mathematics, at an advanced undergraduate or beginning graduate level. Prerequisite: Departmental consent. (Typically offered: Irregular) May be repeated for up to 12 hours of degree credit.

MATH 50103. 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. Graduate degree credit will not be awarded for both MATH 41103 (or MATH 51203) and MATH 50103. Prerequisite: Graduate standing or departmental consent. (Typically offered: Irregular)

MATH 50203. 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. (Typically offered: Fall Odd Years)

MATH 50303. Advanced Calculus with Connections to School Mathematics Teaching. 3 Hours.
Rigorous development of the real numbers, continuity, differentiation, and integration. Graduate degree credit will not be awarded for both MATH 45103 (or MATH 55003) and MATH 50303. Prerequisite: Departmental consent. (Typically offered: Irregular)

MATH 5040V. Special Topics for Teachers. 1-6 Hour.
Current topics in mathematics of interest to secondary school teachers. Prerequisite: Graduate standing or departmental consent. (Typically offered: Irregular) May be repeated for degree credit.

MATH 50503. Probability & Statistics with Connections to School Mathematics. 3 Hours.
An advanced perspective of probability and statistics as contained in the high school mathematics curriculum with connections to other components of school mathematics. The content is guided by the content of the high school probability and statistics of the Common Core State Standards for Mathematics. Prerequisite: Graduate standing. (Typically offered: Spring)

MATH 5070V. 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: Departmental consent. (Typically offered: Irregular) May be repeated for up to 6 hours of degree credit.

MATH 5100V. 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. (Typically offered: Fall and Spring) May be repeated for up to 3 hours of degree credit.

MATH 51103. Introduction to Abstract Algebra II. 3 Hours.
Topics in abstract algebra including finite abelian groups, linear groups, factorization in commutative rings and Galois theory. Graduate degree credit will not be given for both MATH 41103 and MATH 51103. Prerequisite: MATH 31103. (Typically offered: Spring)

MATH 51203. 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 31103, and graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Fall)

MATH 51303. Algebra II. 3 Hours.
Continuation of MATH 51203. Prerequisite: MATH 51203, and graduate standing in mathematics or statistics. (Typically offered: Spring)

MATH 51503. Advanced Linear Algebra. 3 Hours.
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 41003 and MATH 51503. Prerequisite: Graduate standing. (Typically offered: Fall)

MATH 51603. 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. Graduate degree credit will not be given for both MATH 41603 and MATH 51603. Prerequisite: MATH 24004. (Typically offered: Irregular)

MATH 52103. 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. Graduate degree credit will not be given for both MATH 45103 and MATH 52103. Prerequisite: Graduate standing. (Typically offered: Fall)

MATH 52203. Advanced Calculus II. 3 Hours.
The Riemann-Stieltjes 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 45203 and MATH 52203. Prerequisite: MATH 45103 or MATH 52103. (Typically offered: Spring)

MATH 5250V. Internship in Professional Practice. 1-3 Hour.
Professional work experience involving significant use of mathematics or statistics in business, industry or government. Graduate degree credit will not be given for both MATH 4050V and MATH 5250V. (Typically offered: Fall, Spring and Summer) May be repeated for up to 3 hours of degree credit.

MATH 52603. 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. Graduate degree credit will not be given for both MATH 42503 and MATH 52603. Prerequisite: MATH 26103, MATH 28003, or PHIL 22003. (Typically offered: Fall)
This course is cross-listed with PHIL 52503.

MATH 53103. Partial Differential Equations. 3 Hours.
Laplace's equation, Heat equation, Wave Equation, Method of Characteristics. Prerequisite: MATH 44203, MATH 45103, and graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Fall)

MATH 53203. Partial Differential Equations II. 3 Hours.
Fourier Transforms, Sobolev Spaces, Elliptic Regularity. Prerequisite: MATH 53103 and graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Spring)

MATH 53603. 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 43503 or MATH 43603. Prerequisite: Graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Fall)
This course is cross-listed with PHYS 53603.

MATH 53703. Finite Element Methods and Solution of Sparse Linear. 3 Hours.
Provides an in-depth understanding of numerical methods for the solution of partial differential equations using Finite Element Methods, Direct and Iterative Methods for the Sparse Linear Systems. Prerequisite: MATH 53903. (Typically offered: Spring)

MATH 53803. Numerical Analysis. 3 Hours.
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 43603 and MATH 53803. Prerequisite: Graduate standing. (Typically offered: Fall)

MATH 53903. Numerical Linear Algebra. 3 Hours.
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 43503 and MATH 53903. Prerequisite: Graduate standing. (Typically offered: Spring)
This course is equivalent to MATH 43503.

MATH 54003. Numerical Linear Algebra II. 3 Hours.
Provides an in-depth understanding of numerical methods for the solution of large scale eigenvalue problems arising in science and engineering applications including theory, implementation and applications. Prerequisite: MATH 53903. (Typically offered: Fall)

MATH 54203. Introduction to Partial Differential Equations. 3 Hours.
Separation of variables, Fourier transform, and Laplace transform methods for the solution of partial differential equations. Topics include Fourier series, Fourier-Bessel series, orthogonal expansions, and the error function. Does not count towards degree credit in MATH. Prerequisite: Graduate standing. (Typically offered: Fall, Spring and Summer)

MATH 54403. Complex Variables. 3 Hours.
Complex analysis, series, and conformal mapping. Graduate degree credit will not be given for both MATH 44403 and MATH 54403. Prerequisite: MATH 26103 or MATH 28003, and MATH 25804. (Typically offered: Fall)

MATH 54503. 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 55103, and graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Spring Odd Years)

MATH 55003. 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 45203 or MATH 52203, and graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Fall)

MATH 55103. Theory of Functions of a Real Variable II. 3 Hours.
Measure and integration on abstract measure spaces, signed measures, Hahn decomposition, Radon-Nikdoym theorem, Lebesque decomposition, measures on algebras and their extensions, product measures, and Fubini's theorem. Prerequisite: MATH 55003, and graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Spring)

MATH 55203. 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 45103 or MATH 52103. (Typically offered: Fall)

MATH 55303. Theory of Functions of a Complex Variable II. 3 Hours.
Riemann Mapping Theorem, analytic continuation, harmonic functions, and entire functions. Prerequisite: MATH 55203, and graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Spring)

MATH 56003. Differential Geometry. 3 Hours.
Topics include: classical differential geometry of curves and surfaces in 3-space, differential forms and vector fields. Graduate degree credit will not be given for both MATH 45003 and MATH 56003. Prerequisite: MATH 26004. (Typically offered: Irregular)

MATH 57003. 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 45103 or MATH 52103, and graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Fall Even Years)

MATH 57103. 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 57003, and graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Spring Odd Years)

MATH 57203. 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 45103 or MATH 52103 and graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Fall Odd Years)

MATH 57303. 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 57203 and graduate standing in mathematics or statistics, or department consent. (Typically offered: Spring Even Years)

MATH 58003. Introduction to Point-Set Topology. 3 Hours.
A study of topological spaces including continuous transformations, connectedness and compactness. Graduate degree credit will not be given for both MATH 47003 and MATH 58003. Prerequisite: MATH 45103 or MATH 52103. (Typically offered: Irregular)

MATH 5990V. Research Topics in Mathematics. 1-3 Hour.
Current research interests in mathematics. Graduate degree credit will not be given for both MATH 4990V and MATH 5990V. Prerequisite: Departmental consent. (Typically offered: Irregular) May be repeated for up to 12 hours of degree credit.

MATH 6100V. Directed Readings. 1-6 Hour.
Directed readings. Prerequisite: Departmental consent. (Typically offered: Irregular) May be repeated for up to 18 hours of degree credit.

MATH 6190V. Topics in Algebra. 1-6 Hour.
Current research interests in algebra. Prerequisite: Graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.

MATH 62003. 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 55103. (Typically offered: Fall)

MATH 62103. 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 theory of hypothesis testing, Large sample approximations, large sample properties of estimators. Prerequisite: MATH 62003. (Typically offered: Spring)

MATH 6590V. Topics in Analysis. 1-6 Hour.
Current research interests in analysis. Prerequisite: Graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.

MATH 6790V. Topics in Topology. 1-6 Hour.
Current research interest in topology. Prerequisite: Graduate standing in mathematics or statistics, or departmental consent. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.

MATH 7000V. Doctoral Dissertation. 1-18 Hour.
Doctoral Dissertation. Prerequisite: Doctoral candidacy in mathematics. (Typically offered: Fall, Spring and Summer) May be repeated for degree credit.