

MATH-MATHEMATICS

MATH 0999 Remedial Transfer Credit 10 Credit Hours

This is not a course offered at the University of Oklahoma. It is used to denote remedial transfer credit for which there is no OU equivalent course.

MATH 1471 Mathematics for Critical Thinking Corequisite 1 Credit Hour

Prerequisite: A satisfactory score on the math placement examination; Corequisite: MATH 1473. This course is designed as a corequisite supplement to MATH 1473 (Math for Critical Thinking). It covers material that supports the learning of key arithmetic, algebra topics, and terminology needed to address common contextualized scenarios involving quantities and numeration (e.g., personal financial mathematics and interpretation of data representations found in media). The course also further emphasizes topics from MATH 1473. (F, Sp, Su)

MATH 1473 Mathematics for Critical Thinking 3 Credit Hours

Prerequisite: "C" or better in DMAT 0123 at OU, or satisfactory score on the math assessment. A study of the mathematics needed for the critical evaluation of quantitative information and arguments including logic, critical appraisal of graphs and tables; use of simple mathematical models and an introduction to elementary statistics. (F, Sp, Su) [I-M].

MATH 1501 College Algebra Corequisite 1 Credit Hour

Prerequisite: A satisfactory score on the math placement examination; Corequisite: MATH 1503. This course is a corequisite supplement to MATH 1503 (College Algebra), which is designed for students in preparation for engineering calculus. MATH 1501 supports the learning of key algebra topics, including expanding and simplifying algebraic expressions (linear, quadratic, polynomial, rational, radical, exponential, and logarithmic); factoring techniques; and representations of mathematical information. The course also further emphasizes topics from MATH 1503. (F, Sp, Su)

MATH 1503 College Algebra 3 Credit Hours

Prerequisite: "C" or better in DMAT 0123, or satisfactory score on the math assessment. Study of equations, inequalities, functions (linear, absolute value, quadratic, polynomial, rational, radical, exponential, logarithmic). Includes systems of equations; recognizing, utilizing, creating, and converting between symbols, tables, graphs, models. Prerequisite for MATH 1523. A student may not receive credit for this course and MATH 1643. (F, Sp, Su) [I-M].

MATH 1523 Precalculus and Trigonometry 3 Credit Hours

Prerequisite: MATH 1503 or satisfactory score on the math assessment. Primarily concentrates on trigonometric functions and their inverses, trigonometric identities, solutions of triangles, and applications. In addition, limits, vectors and some vector operations, polar coordinates and continuity are introduced. Suitable for students planning to take calculus; intended as prerequisite for MATH 1823. (F, Sp, Su) [I-M].

MATH 1641 Functions and Modeling Corequisite 1 Credit Hour

Prerequisite: A satisfactory score on the math placement examination; Corequisite: MATH 1643. This course is a corequisite supplement to MATH 1643 (Functions & Modeling), which is designed to prepare students for business calculus, as well as other business, life, and social science courses. The 1641 course focuses on key algebra skills and improvement of academic study skills necessary for success in MATH 1643. It also further emphasizes topics covered in MATH 1643. (F, Sp, Su)

MATH 1643 Functions and Modeling for Business, Life and Social Sciences 3 Credit Hours

Prerequisite: "C" or better in DMAT 0123 at OU, or satisfactory score on the math assessment. Study of equations and functions (linear, polynomial, rational, exponential, logarithmic) from various perspectives (symbolic, verbal, numerical, graphical); digital techniques for graphing functions, solving equations, and modeling data using regressions. This course is designed for students in agricultural, business, life/health sciences, or social science majors. A student may not receive credit for this course and MATH 1503. (F, Sp, Su) [I-M].

MATH 1743 Calculus I for Business, Life and Social Sciences 3 Credit Hours

Prerequisite: MATH 1523, MATH 1643, or satisfactory score on the math assessment. Topics in differentiation of polynomial, exponential and logarithmic functions. Applications to the business, life and social sciences, including optimization. A student may not receive credit for this course and MATH 1823. (F, Sp, Su) [I-M].

MATH 1823 Calculus and Analytic Geometry I 3 Credit Hours

Prerequisite: MATH 1523 or satisfactory score on the math assessment. Topics include functions, limits, and continuity; differentiation; and applications of differentiation including related rates, maximum-minimum theory, curve sketching, and optimization. A student may not receive credit for this course and MATH 1743; duplicates 3 hours of MATH 1914. (F, Sp, Su) [I-M].

MATH 1914 Differential and Integral Calculus I 4 Credit Hours

Prerequisite: Satisfactory score on math assessment. Topics include limits and continuity; differentiation; applications of differentiation including related rates, maximum-minimum theory, curve sketching, and optimization; Fundamental Theorem of Calculus; substitution rule; and applications of integration to computation of areas and volumes. Duplicates three hours of MATH 1823 and one hour of MATH 2423. (F, Sp, Su) [I-M].

MATH 2123 Calculus II for Business, Life and Social Sciences 3 Credit Hours

Prerequisite: MATH 1743. Integration of polynomial, exponential and logarithmic functions, including u-substitution. Applications of integrals to the business, life and social sciences, including probability. Partial derivatives including multivariable optimization, Lagrange multipliers, and least squares. A student cannot receive credit for this course and MATH 2423. (Sp) [I-M].

MATH 2213 Mathematical Systems 3 Credit Hours

Prerequisite: plane geometry, intermediate algebra, enrollment in an appropriate elementary teachers' program. A systematic analysis of arithmetic and a presentation of intuitive algebra and geometry. Not open to students in the University College. (F, Sp, Su)

MATH 2223 Data Analysis and Geometric Systems 3 Credit Hours

Prerequisite: 0123 at OU or satisfactory score on math placement test and admission to 0802A, 0808A, or 0823A degree programs. Algebra and the structure of number systems, functional relationships, informal geometry. Course is not open to students in University College. (F, Sp)

MATH 2423 Calculus and Analytic Geometry II 3 Credit Hours

Prerequisite: MATH 1823 or MATH 1914. Topics include integration and its applications; calculus of transcendental functions; indeterminate forms; techniques of integration; and improper integrals. A student may not receive credit for this course and MATH 2123; duplicates one hour of MATH 1914 and two hours of MATH 2924. (F, Sp, Su) [I-M].

- MATH 2433 Calculus and Analytic Geometry III 3 Credit Hours**
Prerequisite: MATH 2423 or MATH 2924. Polar coordinates, parametric equations, sequences, infinite series, vector analysis. (F, Sp, Su)
- MATH 2443 Calculus and Analytic Geometry IV 3 Credit Hours**
Prerequisite: 2433. Vector calculus; functions of several variables; partial derivatives; gradients, extreme values and differentials of multivariate functions; multiple integrals; line and surface integrals. (F, Sp, Su)
- MATH 2513 Discrete Mathematical Structures 3 Credit Hours**
Prerequisite: MATH 2423 or MATH 2924 or concurrent enrollment.
A course for math majors or prospective math majors. Provides an introduction to discrete concepts such as finite sets and structures, and their properties and applications. Also exposes students to the basic procedures and styles of mathematical proof. Topics include basic set theory, functions, integers, symbolic logic, predicate calculus, induction, counting techniques, graphs and trees. Other topics from combinatorics, probability, relations, Boolean algebras or automata theory may be covered as time permits. (F, Sp, Su)
- MATH 2924 Differential and Integral Calculus II 4 Credit Hours**
Prerequisite: MATH 1914 with a grade of C or better. Topics include calculus of transcendental functions; indeterminate forms; techniques of integration; improper integrals, parametric curves; polar coordinates, infinite sequences and series, vectors in two and three dimensions. Duplicates two hours of MATH 2423 and two hours of MATH 2433. (F, Sp, Su)
- MATH 2934 Differential and Integral Calculus III 4 Credit Hours**
Prerequisite: 2924 with grade of C or better. Vectors and vector functions, functions of several variables, partial differentiation and gradients, multiple integration, line and surface integrals, Green-Stokes-Gauss theorems. Duplicates one hour of 2433 and three hours of 2443. (F, Sp, Su)
- MATH 2970 Special Topics/Seminar 1-3 Credit Hours**
1 to 3 hours. Prerequisite: Permission of instructor. May be repeated; maximum credit nine hours. Special topics or seminar course for content not currently offered in regularly scheduled courses. May include library and/or laboratory research and field projects. (Irreg.)
- MATH 3113 Introduction to Ordinary Differential Equations 3 Credit Hours**
Prerequisite: MATH 2423 or MATH 2924. First order ordinary differential equations, linear differential equations with constant coefficients, two-by-two linear systems, Laplace transformations, phase planes and stability. Duplicates two hours of MATH 3413. (F, Sp, Su)
- MATH 3333 Linear Algebra I 3 Credit Hours**
Prerequisite: MATH 2123 or MATH 1823 or MATH 1914 or permission of instructor. Systems of linear equations, determinants, finite dimensional vector spaces, linear transformations and matrices, characteristic values and vectors. (F, Sp, Su)
- MATH 3401 Numerical Methods With Matlab 1 Credit Hour**
Prerequisite: 3413 or concurrent enrollment. Programming with MATLAB. Numerical solution of nonlinear equations. Matrices and linear algebraic equations, regression, interpolation, splines. Numerical integration. Numerical solution of systems of ordinary differential equations. Numerical solution of partial differential equation. Laboratory (F, Sp)
- MATH 3413 Physical Mathematics I 3 Credit Hours**
Prerequisite: MATH 2443 or MATH 2934 or concurrent enrollment.
Complex numbers and functions. Fourier series, solution methods for ordinary differential equations and partial differential equations, Laplace transforms, series solutions, Legendre's equation. Duplicates two hours of MATH 3113. (F, Sp)
- MATH 3423 Physical Mathematics II 3 Credit Hours**
Prerequisite: MATH 2443 or MATH 2934, MATH 3413. The Fourier transform and applications, a survey of complex variable theory, linear and nonlinear coordinate transformations, tensors, elements of the calculus of variations. (F)
- MATH 3440 Mentored Research Experience 3 Credit Hours**
0 to 3 hours. Prerequisites: ENGL 1113 or equivalent, and permission of instructor. May be repeated; maximum credit 12 hours. For the inquisitive student to apply the scholarly processes of the discipline to a research or creative project under the mentorship of a faculty member. Student and instructor should complete an Undergraduate Research & Creative Projects (URCP) Mentoring Agreement and file it with the URCP office. Not for honors credit. (F, Sp, Su)
- MATH 3960 Honors Reading 1-3 Credit Hours**
1 to 3 hours. Prerequisite: admission to Honors Program. May be repeated; maximum credit six hours. Consists of topics designated by the instructor in keeping with the student's major program. Covers materials not usually presented in the regular courses. (F, Sp, Su)
- MATH 3970 Honors Seminar 1-3 Credit Hours**
1 to 3 hours. Prerequisite: admission to Honors Program. May be repeated; maximum credit six hours. Projects covered will vary. The content will deal with concepts not usually presented in regular coursework. (F, Sp)
- MATH 3980 Honors Research 1-3 Credit Hours**
1 to 3 hours. Prerequisite: admission to Honors Program. May be repeated; maximum credit six hours. Will provide an opportunity for the gifted Honors candidate to work at a special project in the student's field. (F, Sp, Su)
- MATH 3990 Independent Study 1-3 Credit Hours**
1 to 3 hours. Prerequisite: one course in general area to be studied; permission of instructor and department. Overall grade point average of 2.50 or better. May be repeated; maximum credit six hours. Contracted independent study for topic not currently offered in regularly scheduled courses. Independent study may include library and/or laboratory research and field projects. (F, Sp, Su)
- MATH G4073 Numerical Analysis I 3 Credit Hours**
Prerequisite: 3113 or 3413. Solution of linear and nonlinear equations, approximation of functions, numerical integration and differentiation, introduction to analysis of convergence and errors, pitfalls in automatic computation, one-step methods in the solutions of ordinary differential equations. (F)
- MATH 4093 Applied Numerical Methods 3 Credit Hours**
(Slashlisted with MATH 5093) Prerequisite: MATH 2443 or MATH 2934, MATH 3113 or MATH 3413, MATH 3333 or MATH 4373, or permission of instructor. Numerical treatment of ordinary differential equations, numerical linear algebra and applications, basic numerical methods for partial differential equations. No student may earn credit for both 4093 and 5093. (Alt. Sp.)
- MATH G4103 Introduction to Functions of a Complex Variable 3 Credit Hours**
Prerequisite: 3113. Complex analytic functions, conformal mappings, complex integrals. Taylor and Laurent series, integration by the method of residues, complex analytic functions and potential theory. (Sp)

- MATH 4123 Fourier Transforms 3 Credit Hours**
(Slashlisted with MATH 5123) Prerequisite: MATH 2443 or MATH 2934, MATH 3113 or MATH 3413, MATH 3333, or permission of instructor. Fourier series, classical Fourier transform, discrete Fourier transform, distributions and Fourier transforms. Sampling and Shannon's Theorem. No student may earn credit for both 4123 and 5123. (F)
- MATH G4163 Introduction to Partial Differential Equations 3 Credit Hours**
Prerequisite: MATH 2443 or MATH 2934, MATH 3113 or MATH 3413. Physical models, classification of equations, Fourier series and boundary value problems, integral transforms, the method of characteristics. (F, Sp, Su)
- MATH 4193 Introductory Mathematical Modeling 3 Credit Hours**
Prerequisite: MATH 3113 or MATH 3413, MATH 3333, MATH 4733 or MATH 4753, or permission of instructor. Mathematics models are formulated for problems arising in various areas where mathematics is applied. Techniques are developed for analyzing the problem and testing validity of proposed model. (Sp)
- MATH G4313 Introduction to Number Theory 3 Credit Hours**
Prerequisite: 2513 and 3333 or permission of instructor. Topics include factorization and prime numbers, congruence, quadratic residues and reciprocity, continued fractions and approximations, Diophantine equations, arithmetic functions, and selected applications. (Irreg.)
- MATH G4323 Introduction to Abstract Algebra I 3 Credit Hours**
Prerequisite: MATH 3333 and MATH 2513, or permission of instructor. Concepts from set theory; the system of natural numbers, extension from the natural numbers to the integers; semigroups and groups; rings, integral domain and fields. (F, Sp)
- MATH G4333 Introduction to Abstract Algebra II 3 Credit Hours**
Prerequisite: 4323. Extensions of rings and fields, elementary factorization theory; groups with operators; modules and ideals; lattices. (Sp)
- MATH 4373 Abstract Linear Algebra 3 Credit Hours**
(Slashlisted with 5373) Prerequisite: 3333. Vector spaces over arbitrary fields, bases, dimension, linear transformations and matrices, similarity and its canonical forms (rational, Jordan), spectral theorem and diagonalization of quadratic forms. No student may earn credit for both 4373 or 5373. (F, Sp)
- MATH 4383 Applied Modern Algebra 3 Credit Hours**
(Slashlisted with 5383) Prerequisite: 3333. Topics from the theory of error correcting codes, including Shannon's theorem, finite fields, families of linear codes such as Hamming, Golay, BCH, and Reed-Solomon codes. Other topics such as Goppa codes, group codes, and cryptography as time permits. No student may earn credit for both 4383 and 5383. (Sp)
- MATH G4433 Introduction to Analysis I 3 Credit Hours**
Prerequisite: MATH 2433 or MATH 2924, and MATH 2513 or permission of instructor. Review of real number system. Sequences of real numbers. Topology of the real line. Continuity and differentiation of functions of a single variable. (F, Sp, Su)
- MATH 4443 Introduction to Analysis II 3 Credit Hours**
(Slashlisted with 5443) Prerequisite: 4433. Integration of functions of a single variable. Series of real numbers. Series of functions. Differentiation of functions of more than one variable. No student may earn credit for both 4443 and 5443. (Sp)
- MATH 4513 Senior Mathematics Seminar 3 Credit Hours**
Prerequisite: MATH 2443 or MATH 2934; MATH 2513; MATH 3113 or MATH 3413; MATH 3333; and senior standing. Capstone course which synthesizes ideas from different areas of mathematics with emphasis on current topics of interest. The course will involve student presentations, written projects and problem solving. (F, Sp) [V].
- MATH G4643 Topics in Geometry and Combinatorics 3 Credit Hours**
Prerequisite: 3333. May be repeated with permission of instructor; maximum credit six hours. Topics may include convexity (convex sets, combinatorial theorems in finite dimensional Euclidean space), graph theory, finite geometries, foundations of geometry. (F, Sp)
- MATH 4653 Introduction To Differential Geometry I 3 Credit Hours**
(Slashlisted with MATH 5653) Prerequisite: MATH 2443 or MATH 2934, and MATH 3333, or permission of instructor. Elementary theory of curves and surfaces in three-dimensional Euclidean space, differentiable manifolds, Riemannian geometry of two dimensions, Gauss Theorem Egregium. No student may earn credit for both 4653 and 5653. (F)
- MATH 4673 Graph Theory I 3 Credit Hours**
(Slashlisted with 5673) Prerequisite: 2513 or permission of instructor. An introduction to the theory of graphs. Topics include basic definitions, cutpoints, blocks, trees, connectivity and Menger's theorem. No student may earn credit for both 4673 and 5673. (F)
- MATH G4733 Mathematical Theory of Probability 3 Credit Hours**
Prerequisite: MATH 2443 or MATH 2934 or concurrent enrollment. Probability spaces, counting techniques, random variables, moments, special distributions, limit theorems. (F)
- MATH 4743 Introduction to Mathematical Statistics 3 Credit Hours**
(Slashlisted with 5743) Prerequisite: 4733. Mathematical development of basic concepts in statistics: estimation, hypothesis testing, sampling from normal and other populations, regression, goodness-of-fit. No student may earn credit for both 4743 and 5743. (Sp)
- MATH G4753 Applied Statistical Methods 3 Credit Hours**
Prerequisite: MATH 2123 or MATH 2423 or MATH 2924 or permission of instructor. Estimation, hypothesis testing, analysis of variance, regression and correlation, goodness-of-fit, other topics as time permits. Emphasis on applications of statistical methods. (F, Sp, Su)
- MATH 4773 Applied Regression Analysis 3 Credit Hours**
(Slashlisted with 5773) Prerequisite: 3333, 4733 or 4753 or any statistical probability course at an equivalent level. The general regression problem of fitting an equation involving a single dependent variable and several independent variables, estimation and tests of regression parameters, residual analysis, selecting the "best" regression equation. No student may earn credit for both 4773 and 5773. (Alt. F)
- MATH 4793 Advanced Applied Statistics 3 Credit Hours**
(Slashlisted with 5793) Prerequisite: 4743 or 4753 or equivalent. Survey of advanced applied statistical methods other than applied regression, including exploratory data analysis, analysis of multivariate data (principal components: analysis, multiple analysis of variance, cluster analysis, etc.), and introduction to non-parametric methods. No student may earn credit for both 4793 and 5793. (Alt. F)
- MATH 4803 Topics in Mathematics 3 Credit Hours**
Prerequisite: permission of instructor. May be repeated with change of content; maximum credit nine hours. Topics may include any area of mathematics; these will be substantial and fundamental subjects not offered in regular courses. (F, Sp, Su)

- MATH G4853 Introduction to Topology 3 Credit Hours**
Prerequisite: MATH 2433 or MATH 2924; and MATH 2513; or permission of instructor. Metric spaces and topological spaces, continuity, connectedness, compactness and related topics. (Sp)
- MATH 4960 Directed Readings 1-4 Credit Hours**
1 to 4 hours. Prerequisite: good standing in University; permission of instructor and dean. May be repeated; maximum credit four hours. Designed for upper-division students who need opportunity to study a specific problem in greater depth than formal course content permits. (Irreg.)
- MATH 4970 Special Topics/Seminar 1-3 Credit Hours**
1 to 3 hours. Prerequisite: Senior standing or permission of instructor. May be repeated; maximum credit nine hours. Special topics or seminar course for content not currently offered in regularly scheduled courses. May include library and/or laboratory research and field projects. (Irreg.)
- MATH 4990 Independent Study 1-3 Credit Hours**
1 to 3 hours. Prerequisite: three courses in general area to be studied, permission of instructor and department. May be repeated; maximum credit six hours. Contracted independent study for topic not currently offered in regularly scheduled courses. Independent study may include library and/or laboratory research and field projects. (Sp)
- MATH 5093 Applied Numerical Methods 3 Credit Hours**
(Slashlisted with MATH 4093) Prerequisite: graduate standing and MATH 2443 or MATH 2934, MATH 3113 or MATH 3413, MATH 3333 or MATH 4373, or permission of instructor. Numerical treatment of ordinary differential equations, numerical linear algebra and applications, basic numerical methods for partial differential equations. No student may earn credit for both MATH 4093 and MATH 5093. (Alt. Sp.)
- MATH 5103 Mathematical Models 3 Credit Hours**
Prerequisite: permission of instructor or admission to the M.S. program. May be repeated with change of content; maximum credit six hours. Mathematical models are formulated for problems arising in various areas in which mathematics has been applied. In each case, techniques are developed for analyzing the resulting mathematical problem, and this analysis is used to test the validity of the model. (Sp)
- MATH 5123 Fourier Transforms 3 Credit Hours**
(Slashlisted with MATH 4123) Prerequisite: graduate standing and MATH 2443 or 2934, MATH 3113 or MATH 3413, MATH 3333, or permission of the instructor. Fourier series, classical Fourier transform, discrete Fourier transform, distributions and Fourier transforms. Sampling and Shannon's Theorem. No student may earn credit for both 4123 and 5123. (F)
- MATH 5163 Partial Differential Equations 3 Credit Hours**
Prerequisite: 4163 or permission of instructor. First order equations, Cauchy problem for higher order equations, second order equations with constant coefficients, linear hyperbolic equations. (Sp)
- MATH 5173 Advanced Numerical Analysis I 3 Credit Hours**
Prerequisite: 4433, 4443 or permission of instructor. Topics may include: error analysis of numerical methods for optimization and initial value problems, numerical approximation of aspects of control problems. (Alt. F)
- MATH 5183 Advanced Numerical Analysis II 3 Credit Hours**
Prerequisite: 4433, 4443 or permission of instructor. Topics may include: analysis of spline approximations as a basis of the finite element method, error analysis for finite element approximation of elliptic and parabolic boundary value problems. (Alt. Sp)
- MATH 5253 Introduction to Mathematics Pedagogy Research 3 Credit Hours**
Prerequisite: Graduate standing in mathematics or permission of the instructor. This course is intended for students who will be consumers of mathematics education research as well as those who will be producers of this research. The course offers an overview of the mathematics pedagogy research process and a detailed survey of selected aspects of this process. Particular topics including reviewing existing mathematics teaching research literature, designing research studies, gathering research data, analyzing research data, and reporting pedagogical research. (F)
- MATH 5263 Issues and Problems in Mathematics Pedagogy 3 Credit Hours**
Prerequisite: graduate standing in mathematics or permission of instructor. May be repeated with change of content; maximum credit 12 hours. Considers current issues and perennial problems in undergraduate mathematics teaching. Potential topics include, but are not limited to, use of technology in mathematics instruction, use of group work and other instructional strategies actively engaging students in Mathematics learning, the nature of mathematics learning, research-based practices in teaching undergraduate mathematics, issues of gender and diversity in undergraduate mathematics, the nature of the undergraduate mathematics curriculum. (Sp)
- MATH 5303 Topics in Group Theory 3 Credit Hours**
Prerequisite: 4323 or permission of instructor. May be repeated with change of content; Maximum credit 15 hours. Topics may include permutation groups, invariant subgroups, prime power groups, abelian groups, generators and relations, free groups, solvable and nilpotent groups, semi-direct products and extensions, automorphism groups, reflection groups, coxeter groups, crystallographic groups, matrix groups and representation group actions. (Irreg.)
- MATH 5333 Topics in Number Theory 3 Credit Hours**
Prerequisite: at least one mathematics course numbered above 3000, other than 4232. May be repeated with change of content; maximum credit nine hours. Topics may include congruencies, arithmetic functions, quadratic reciprocity, continued fractions, diophantine equations, primality testing, factorization methods, cryptography, quadratic forms and quadratic fields, computational number theory, additive number theory, coding theory, p-adic numbers. (Irreg.)
- MATH 5353 Abstract Algebra I 3 Credit Hours**
Prerequisite: 4323, permission of instructor. Groups, Sylow theorems, group actions, group presentations. Rings, ideals, polynomial rings, unique factorization. Fields, algebraic and transcendental extensions. (F)
- MATH 5363 Abstract Algebra II 3 Credit Hours**
Prerequisite: 5353. Galois theory, solvability. Modules over a principal ideal domain. Noetherian ideal theory. Group representations, semisimple rings. Classical groups. (Sp)
- MATH 5373 Abstract Linear Algebra 3 Credit Hours**
(Slashlisted with 4373) Prerequisite: 3333. Vector spaces over arbitrary fields, bases, dimension, linear transformations and matrices, similarity and its canonical forms (rational, Jordan), spectral theorem and diagonalization of quadratic forms. No student may earn credit for both 4373 and 5373. (F, Sp)

- MATH 5383 Applied Modern Algebra 3 Credit Hours**
(Slashlisted with MATH 4383) Prerequisite: MATH 3333. Topics from the theory of error correcting codes, including Shannon's theorem, finite fields, families of linear codes such as Hamming, Golay, BCH, and Reed-Solomon codes. Other topics such as Goppa codes, group codes, and cryptography as time permits. No student may earn credit for both 4383 and 5383. (Sp)
- MATH 5403 Calculus of Variations 3 Credit Hours**
Prerequisite: 4433 or 3423 or 4163. Linear spaces, global and local theories of optimization, necessary conditions for relative extrema of integrals. (Irreg.)
- MATH 5423 Complex Analysis I 3 Credit Hours**
Prerequisite: 4433. The complex numbers, topologies of the extended plane and related sphere, elementary functions, power series, properties of general holomorphic functions. The integral of a complex-valued function over an oriented rectifiable curve, the classical theorems on integrals, Taylor and Laurent expansions, analytic continuation, introduction to Riemann surfaces. (Alt. F)
- MATH 5443 Introduction To Analysis II 3 Credit Hours**
(Slashlisted with 4443) Prerequisite: 4433. Integration of functions of a single variable. Series of real numbers. Series of functions. Differentiation of functions of more than one variable. No student may earn credit for both 4443 and 5443. (Sp)
- MATH 5453 Real Analysis I 3 Credit Hours**
Prerequisite: 4433 or permission of instructor. Lebesgue measure and integration theory, absolutely continuous functions, metric spaces. (F)
- MATH 5463 Real Analysis II 3 Credit Hours**
Prerequisite: 5453. General measure and integration theory, Banach spaces, topics from related areas. (Sp)
- MATH 5653 Introduction To Differential Geometry I 3 Credit Hours**
(Slashlisted with MATH 4653) Prerequisite: graduate standing and MATH 2443 or MATH 2934, and MATH 3333, or permission of instructor. Elementary theory of curves and surfaces in three-dimensional Euclidean space, differentiable manifolds, Riemannian geometry of two dimensions, Gauss Theorem Egregium. No student may earn credit for both 4653 and 5653. (F)
- MATH 5673 Graph Theory I 3 Credit Hours**
(Slashlisted with 4673) Prerequisite: 2513 or permission of instructor. An introduction to the theory of graphs. Topics include basic definitions, cutpoints, blocks, trees, connectivity and Menger's theorem. No student may earn credit for both 4673 and 5673. (F)
- MATH 5693 Topics in Geometry and Combinatorics I 3 Credit Hours**
Prerequisite: permission of instructor. May be repeated with permission of instructor; maximum credit 12 hours. Topics may include convexity, combinatorial geometry, graph theory, or Riemannian geometry. (F, Sp, Su)
- MATH 5743 Introduction to Mathematical Statistics 3 Credit Hours**
(Slashlisted with 4743) Prerequisite: 4733. Mathematical development of basic concepts in statistics: estimation, hypothesis testing, sampling from normal and other populations; regression, goodness of fit. No student may earn credit for both 4743 and 5743. (Sp)
- MATH 5763 Introduction to Stochastic Processes 3 Credit Hours**
Prerequisite: 4733 or permission of instructor. Stochastic processes in discrete time including random walks, recurrent events, Markov chains and branching processes. Processes in continuous time including linear and nonlinear birth-death processes and diffusions. Applications taken from economics, engineering, operations research. (Irreg.)
- MATH 5773 Applied Regression Analysis 3 Credit Hours**
(Slashlisted with 4773) Prerequisite: 3333, 4733 or 4753 or any statistical probability course at an equivalent level. The general regression problem of fitting an equation involving a single dependent variable and several independent variables, estimation and tests of regression parameters, residual analysis, selecting the "best" regression equation. No student may earn credit for both 4773 and 5773. (Alt. F)
- MATH 5793 Advanced Applied Statistics 3 Credit Hours**
(Slashlisted with 4793) Prerequisite: 4743 or 4753 or equivalent. Survey of advanced applied statistical methods other than applied regression, including exploratory data analysis, analysis of multivariate data (principal components: analysis, multiple analysis of variance, cluster analysis, etc.), and introduction to non-parametric methods. No student may earn credit for both 4793 and 5793. (Alt. F)
- MATH 5803 Topics in Mathematics 3 Credit Hours**
Prerequisite: permission of instructor. May be repeated with change of content; maximum credit fifteen hours. Topics may include any area of mathematics; these will be substantial and fundamental subjects not offered in regular courses. (F, Sp, Su)
- MATH 5853 Topology I 3 Credit Hours**
Prerequisite: 2433 and 2513. Set theory, separation axioms, connectedness, compactness, continuity, metric spaces, nets and sequences. (F)
- MATH 5863 Topology II 3 Credit Hours**
Prerequisite: 5853. Metrization, product and quotient spaces, function spaces, dimension theory, Hilbert spaces, homotopy, simplicial complexes, continua. (Sp)
- MATH 5900 Graduate Mathematics Readings 1-3 Credit Hours**
1 to 3 hours. Prerequisite: six-hour mathematics sequence at the 5000+ level. May be repeated with change of content; maximum credit fifteen hours. Special background readings in advanced mathematical topics as preparation for later dissertation work. (F, Sp, Su)
- MATH 5920 Seminar--Algebra and Theory of Numbers 1-2 Credit Hours**
1 to 2 hours. Prerequisite: permission of instructor. May be repeated with change of content; maximum credit 12 hours. (F, Sp)
- MATH 5930 Seminar--Geometry and Topology 1-2 Credit Hours**
1 to 2 hours. Prerequisite: permission of instructor. May be repeated with change of content; maximum credit 12 hours. (F, Sp)
- MATH 5950 Seminar-Undergraduate Mathematics Curriculum & Pedagogy 1-2 Credit Hours**
1 to 2 hours. May be repeated with change of content; maximum credit 12 hours. This seminar will explore the current research literature on undergraduate mathematics curriculum and pedagogy. (F, Sp)
- MATH 5960 Directed Readings 1-3 Credit Hours**
1 to 3 hours. Prerequisite: graduate standing and permission of department. May be repeated; maximum credit twelve hours. Directed readings and/or literature reviews under the direction of a faculty member. (F, Sp, Su)
- MATH 5970 Special Topics/Seminar 1-3 Credit Hours**
1 to 3 hours. Prerequisite: Graduate standing or permission of instructor. May be repeated; maximum credit nine hours. Special topics or seminar course for content not currently offered in regularly scheduled courses. May include library and/or laboratory research and field projects. (Irreg.)
- MATH 5980 Research for Master's Thesis 2-9 Credit Hours**
Variable enrollment, two to nine hours; maximum credit applicable toward degree, four hours. (F, Sp)

- MATH 5990 Special Problems in Mathematics** 1-2 Credit Hours
1 to 2 hours. An option for all candidates for the master's degree who do not present theses. (F, Sp, Su)
- MATH 6303 Literacy in Algebra** 3 Credit Hours
Prerequisite: Graduate standing and MATH 5363; May be repeated with change of content; maximum credit 15 hours. This course will cover three independent advanced topics in the general area of Algebra. Some past topics have included: plane curves and singularities; introduction to buildings; invariant theory; representation stability; Morita theorems and Tannaka duality; computational commutative algebra; quiver representations; friezes; p-adic and motivic integration; introduction to algebraic analysis. (Irreg.)
- MATH 6333 Lie Theory I** 3 Credit Hours
Prerequisites: 5363 and 5863 or permission of the instructor. Basic properties of Lie algebras, nilpotent and solvable Lie algebras, semi-simple Lie algebras, root systems and classification theorems. (Irreg.)
- MATH 6343 Lie Theory II** 3 Credit Hours
Prerequisite: 6333 or permission of the instructor. Representation theory of semi-simple Lie algebras, Lie groups, connections between Lie groups and Lie algebras, structure theory and representation theory of compact Lie groups. (Irreg.)
- MATH 6373 Commutative Algebra** 3 Credit Hours
Prerequisite: 4323, 4333, 5333 or permission of instructor. Commutative rings and their modulus, ideals, prime ideals, Noetherian modules and rings, localization, principal and factorial rings, discrete valuation domains, Dedekind domains, integral ring extensions, dimension theory, tensor products, flat modules, the homofunctor, injective and projective modules, regular rings, Cohen-Macaulay rings. (Irreg.)
- MATH 6383 Algebraic Geometry** 3 Credit Hours
Prerequisite: 6373. Hilbert's Nullstellensatz, the correspondence between ideals and algebraic sets, Zariski topology, irreducible algebraic sets, ringed spaces, morphisms, affine varieties, algebraic varieties, regular maps, sub-varieties and products, bi-rational equivalence, local rings and tangent spaces, differentials, non-singular points. (Irreg.)
- MATH 6393 Topics in Algebra** 3 Credit Hours
Prerequisite: 5353 or permission of instructor. May be repeated with change of content; maximum credit 15 hours. Topics of modern research interest in algebra. (Irreg.)
- MATH 6403 Literacy in Analysis** 3 Credit Hours
Prerequisite: Graduate standing and MATH 5463; May be repeated with change of content; maximum credit 15 hours. This course will cover three independent advanced topics in the general area of Analysis. Some past topics have included: Sobolev spaces; C*-algebras; analysis of partial differential operators; distributions; holomorphic functional calculus; interpolation spaces; symbolic dynamics; Hardy spaces; perturbation theory and fixed point theorems; regularity theory for elliptic PDE. (Irreg.)
- MATH 6473 Functional Analysis I** 3 Credit Hours
Prerequisite: 5463 or permission of instructor. Vector spaces with topology or norm, dual space, theorems on linear operators, spectral theory in Hilbert space, spectral decomposition of operators, convex sets and weak topologies, fixed point theorems. (Alt. F)
- MATH 6483 Functional Analysis II** 3 Credit Hours
Prerequisite: 6473. Banach algebras and harmonic analysis, representations of symmetric rings, unitary representations of a group, rings of operators in Hilbert space, decomposition of ring operators. Introduction to the theory of distributions. (Alt. Sp)
- MATH 6493 Topics in Analysis** 3 Credit Hours
Prerequisite: 5453 or permission of instructor. May be repeated with change of content; maximum credit 15 hours. Topics of modern research interest in analysis. (F, Sp)
- MATH 6673 Differential Geometry I** 3 Credit Hours
Prerequisite: 5853 or permission of instructor. Multilinear algebra, differential manifolds, exterior differential forms, affine connections, Riemannian manifolds. (F)
- MATH 6683 Differential Geometry II** 3 Credit Hours
Prerequisite: 6673. Riemannian manifolds, theory of connections, bundles with classical groups as structure groups, curvature and Betti numbers, complex manifolds. (Sp)
- MATH 6803 Literacy in Topology** 3 Credit Hours
Prerequisite: Graduate standing and MATH 5863; May be repeated with change of content; maximum credit 15 hours. This course will cover three independent advanced topics in the general area of Topology. Some past topics have included: Mostow rigidity; group cohomology; curvature and topology; Morse theory; ergodicity of geodesic flow; Bass-Serre theory; deRham cohomology; introduction to mapping class groups; K-theory; geometry of metric spaces; the homeomorphism group of the circle; topology of 3-manifolds. (Irreg.)
- MATH 6813 Algebraic Topology I** 3 Credit Hours
Prerequisite: 5863. Introduction to homology theory of spaces, fundamental group and covering spaces, higher homotopy groups, CW-complexes and cellular homology, Whitehead and Hurewicz theorems, Eilenberg-Steenrod axioms. (F)
- MATH 6823 Algebraic Topology II** 3 Credit Hours
Prerequisite: 6813. Topics in cohomology and homology theory, universal coefficient theorems, orientation and duality on manifolds. Further topics may include: obstruction theory, cohomology operations, fibre bundles and characteristic classes, theory of sheaves, Eilenberg-MacLane spaces and Postnikov systems, spectral sequences. (Sp)
- MATH 6833 Topics in Topology I** 3 Credit Hours
Prerequisite: 5863. May be repeated with permission of instructor; maximum credit 15 hours. Topics may include algebraic topology, combinatorial topology, linear topological spaces, dimension theory, metrization, continua, decomposition spaces, topology of flat spaces. (F, Sp)
- MATH 6910 Seminar--Analysis** 1-2 Credit Hours
1 to 2 hours. Prerequisite: permission of the instructor. May be repeated with change of content; maximum credit 15 hours. Seminar on analysis and applied mathematics topics. (F, Sp)
- MATH 6930 Seminar--Geometry and Topology** 1-2 Credit Hours
1 to 2 hours. Prerequisite: permission of the instructor. May be repeated with change of content; maximum credit 12 hours. (F, Sp)
- MATH 6960 Directed Readings** 1-3 Credit Hours
1 to 3 hours. Prerequisite: graduate standing or permission of instructor. May be repeated; maximum credit six hours. Directed readings and/or literature review under the direction of a faculty member. (Irreg.)
- MATH 6970 Special Topics/Seminar** 1-3 Credit Hours
1 to 3 hours. Prerequisite: graduate standing or permission of instructor. May be repeated; maximum credit 12 hours. Special topics or seminar course for content not currently offered in regularly scheduled courses. May include library and/or research and field projects. (Irreg.)

MATH 6980 Research for Doctoral Dissertation 2-16 Credit Hours
2 to 16 hours. Prerequisite: Graduate standing and permission of instructor; may be repeated. Directed research culminating in the completion of the doctoral dissertation. (F, Sp, Su)

MATH 6990 Independent Study 1-3 Credit Hours
1 to 3 hours. Prerequisite: Graduate standing and permission of instructor. May be repeated; maximum credit nine hours. Contracted independent study for a topic not currently offered in regularly scheduled courses. Independent study may include library and/or laboratory research and field projects. (Irreg.)