MATHEMATICS (MAT)

MAT 500 Selected Topics (1-6 Credits)
Arts & Sciences
Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester. Repeatable

MAT 503 Matrix Methods for Data Science (3 Credits)
Arts & Sciences
Matrix methods required for data analysis with an emphasis on applications and using software. Matrix norms, orthogonality, eigendecomposition, SVD, LS, QRD, LDA, PCA. Not for math majors or minors. Additional work required of graduate students.
Prereq: MAT 397

MAT 511 Advanced Calculus (3 Credits)
Arts & Sciences
Partial derivatives, implicit functions, integration in several variables, line and surface integrals.
Prereq: (MAT 331 and 397) or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 512 Introduction to Real Analysis II (3 Credits)
Arts & Sciences
Real-number system, set theory and elementary topological properties of the real line, continuity and differentiability, sequences and series, uniform convergence, Riemann integration, and improper integrals.
Prereq: MAT 412 or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 513 Introduction to Complex Analysis (3 Credits)
Arts & Sciences
Complex number system and its arithmetic, geometric representation. Linear transformations. Analytic functions and the Cauchy-Riemann equations. Integration and Cauchy's theorem, Taylor and Laurent series, singularities, poles, and residues. Applications.
Prereq: MAT 412 or 511 or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 517 Partial Differential Equations and Fourier Series (3 Credits)
Arts & Sciences
Partial differential equations, boundary-value problems, Fourier series and orthogonal expansions, Bessel functions, and Legendre polynomials.
Prereq: MAT 485 or 414 or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 518 Fourier Series, Transforms and Wavelets (3 Credits)
Arts & Sciences
Orthogonal functions, Fourier series, Fourier transforms-continuous and discrete, Haar wavelets and multiresolution analysis, applications to signal processing. Additional work required of graduate students.
Prereq: MAT 331 or MAT 485 or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 521 Introduction to Probability (3 Credits)
Arts & Sciences
Algebra of sets. Probability in finite sample spaces. Binomial and multinomial coefficients. Random variables. Expected value and standard deviation. Density functions. Statistical applications.
Prereq: MAT 397 or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 523 Statistical Methods for Data Science (3 Credits)
Arts & Sciences
Statistical methods (such as hypothesis testing, parameter estimation, regression, ANOVA, sampling, experimental design) required for data science. Emphasis on applications and using software. Additional work required for graduate students.
Prereq: MAT 397 and (MAT 222 or CIS 321 or MAT 421 or MAT 521)

MAT 524 Regression Analysis (3 Credits)
Arts & Sciences
Concept, theory, methods, and applications of simple linear regression, multiple linear regression, and logistic regression models; Parameter estimation and testing, Prediction, Regression diagnostics and model adequacy checking, Variable selection and model building.
Prereq: MAT 331 AND (MAT 222 or MAT 421 or MAT 525)
Shared Competencies: Information Literacy and Technological Agility (https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/); Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 525 Mathematical Statistics (3 Credits)
Arts & Sciences
Estimation and confidence intervals. Normal distribution and central limit theorem. Testing hypotheses, chi-square, t, and F distributions. Least squares, regression, and correlation.
Prereq: MAT 521 or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 526 Introduction to Stochastic Processes (3 Credits)
Arts & Sciences
Discrete time Markov chains, Poisson process, continuous time Markov chains and other selected stochastic processes.
Prereq: MAT 521 or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 527 Analysis of Variance and Experimental Design (3 Credits)
Arts & Sciences
One-way, two-way, and multi-way analysis of variance, analysis of covariance, random/mixed effect models, repeated measure analysis, and special designs such as a randomized block design, an incomplete block design, Latin square, and a nested design.
Advisory recommendation Prereq: MAT 222 or MAT 421 or MAT 525
Shared Competencies: Information Literacy and Technological Agility (https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/); Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 528 Probability Models for Actuarial Science (3 Credits)
Arts & Sciences
Applied probability focusing on distributions for actuarial applications. Conditional expectation. Moment generating functions. Limit theorems. Loss and Survival models. Parametric and Non-Parametric estimation. Model assessment. Benefit reserves and risk measures. Additional work required of graduate students.
Prereq: MAT 521

MAT 529 Introduction to Bayesian Statistics (3 Credits)
Arts & Sciences
Concepts of prior and posterior, Bayesian inference for binomial and Poisson distributions, Monte Carlo approximation, Bayesian inference for normal distribution, Gibbs sampling, hierarchical models, multivariate normal distribution, Metropolis-Hastings algorithms, linear regression models.
Advisory recommendation Prereq: MAT 296, MAT 331, MAT 422, and MAT 525

MAT 531 Second Course in Linear Algebra (3 Credits)
Arts & Sciences
Abstract vector spaces and inner product spaces, linear transformations and linear operators, eigenvalues and diagonalization. Primarily for mathematics majors.
Prereq: ((MAT 375 or CIS 375) and MAT 331) or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 532 Applied Linear Algebra (3 Credits)
Arts & Sciences
Factorization of matrices, eigenvalues and eigenvectors, orthogonality. Applications of matrices to such topics as least-squares approximation, fast Fourier transform, difference and differential equations, linear programming, networks, game theory.
Prereq: MAT 331 or 485 or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 534 Introduction to Abstract Algebra (3 Credits)
Arts & Sciences
Theory of groups, rings, and fields, including the integers and polynomial rings.
Prereq: MAT 531 or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 541 Introduction to Number Theory (3 Credits)
Arts & Sciences
Prime numbers, greatest common divisors, congruences. Euler's function, Fermat's theorem, primitive roots, indices, quadratic residues, Legendre and Jacobi symbols, and the quadratic reciprocity law.
Prereq: ((MAT 375 or CIS 375) and MAT 331) or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 545 Introduction to Combinatorics (3 Credits)
Arts & Sciences
Cross-listed with CIS 545
Permutations, combinations, recurrence relations, generating functions, inclusion-exclusion and applications, introductory graph theory.
Prereq: MAT 375 or CIS 375 or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 551 Fundamental Concepts of Geometry (3 Credits)
Arts & Sciences
Synthetic projective geometries. Coordinate systems for projective spaces. Algebraic representation of projective transformations; euclidean, non-euclidean, and affine geometries as real cases of projective geometry.
Prereq: ((MAT 375 or CIS 375) and MAT 331) or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 554 Differential Geometry (3 Credits)
Arts & Sciences
Theory of curves in three-dimensional space, including Frenet's formula, Gaussian and mean curvature, geodesics, developable surfaces, special conformal mappings.
Prereq: MAT 412 or 511 or graduate standing in mathematical sciences
Shared Competencies: Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 562 Elementary Topology (3 Credits)
Arts & Sciences
Metrics and metric spaces, topologies and topological spaces, separation properties, compactness, connectedness, and continuity.
Prereq: ((MAT 375 or CIS 275) and MAT 412) or graduate standing in mathematical sciences
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/); Communication Skills (https://coursecatalog.syracuse.edu/shared-competencies/communication-skills/)

MAT 580 International Course (1-12 Credits)
Arts & Sciences
Offered through SUAbroad by educational institution outside the United States. Student registers for the course at the foreign institution and is graded according to that institution's practice. SUAbroad works with the S.U. academic department to assign the appropriate course level, title, and grade for the student's transcript.
Repeatable

MAT 581 Numerical Methods with Programming (3 Credits)
Arts & Sciences
Approximation methods for solution of nonlinear equations. Interpolation problems. Numerical integration. Solution of ordinary differential equations. Error analysis and writing computer programs. Primarily for mathematics and engineering students.
Prereq: MAT 397 or graduate standing in mathematical sciences
Shared Competencies: Information Literacy and Technological Agility (https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/); Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 590 Independent Study (1-6 Credits)
Arts & Sciences
Exploration of a problem, or problems, in depth. Individual independent study upon a plan submitted by the student. Admission by consent of supervising instructor(s) and the department.
Repeatable

MAT 593 History of Mathematics (3 Credits)
Arts & Sciences
Mathematical concepts in their historical perspective. Character and contributions of the great mathematicians and relation of mathematics to other sciences.
Prereq: (MAT 397 and at least two 500-level math courses) or graduate standing in mathematical sciences
Shared Competencies: Communication Skills (https://coursecatalog.syracuse.edu/shared-competencies/communication-skills/)

MAT 598 Statistics Seminar (3 Credits)
Arts & Sciences
In-depth investigation of one or more statistical topics, applications of statistical methods and tools, real-world data analysis project using software, comprehensive presentation of project findings.
Advisory recommendation Prereq: MAT 422, MAT 524, MAT 525, and MAT 527

MAT 599 Senior Seminar in Mathematics (3 Credits)
Arts & Sciences
Topic Chosen by the instructor. Permission of department.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/); Communication Skills (https://coursecatalog.syracuse.edu/shared-competencies/communication-skills/)

MAT 600 Selected Topics (1-6 Credits)
Arts & Sciences
Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester.
Repeatable

MAT 601 Fundamentals of Analysis I (3 Credits)
Arts & Sciences
Real and complex numbers, elementary point set topology, sequences and series, continuity, differentiation.
Advisory recommendation Prereq: MAT 512 or graduate standing in mathematical sciences

MAT 602 Fundamentals of Analysis II (3 Credits)
Arts & Sciences
Riemann-Stieltjes integration, functional sequences and series, functions of several variables.
Advisory recommendation Prereq: (MAT 601 and 631) or graduate standing in mathematical sciences

MAT 631 Introduction to Algebra I (3 Credits)
Arts & Sciences
Linear algebra, linear transformations, eigenvectors, diagonalization, inner product spaces, groups, quotient groups, group actions, Sylow theorems, finitely generated Abelian groups, rings, unique factorization domains, finitely generated modules over principal ideal domains, fields, Galois theory.
Advisory recommendation Prereq: (MAT 531 and 534) or graduate standing in mathematical sciences

MAT 632 Introduction to Algebra II (3 Credits)
Arts & Sciences
Continuation of MAT 631.
Advisory recommendation Prereq: MAT 631 or graduate standing in mathematical sciences

MAT 645 Graph Theory (3 Credits)
Arts & Sciences
Cross-listed with CIS 645
Fundamentals of graph theory and special topics including networks, matching, connectivity, planarity, and automorphism groups.
Advisory recommendation Prereq: MAT 531 or graduate standing in mathematical sciences

MAT 646 Enumeration, Designs, and Matroids (3 Credits)
Arts & Sciences
Cross-listed with CIS 646
Generating functions, Polya enumeration, set systems, design parameters, finite projective planes, matroids.
Advisory recommendation Prereq: MAT 531 or graduate standing in mathematical sciences

MAT 651 Probability and Statistics I (3 Credits)
Arts & Sciences
Calculus of probabilities, univariate and multivariate random variables and distribution functions, expectations and variance, conditional distributions, transformations of random variables, characteristic functions, basic limit theorems including Borel-Cantelli, Khinchin, Lindeberg- Feller.
Advisory recommendation Prereq: MAT 521 or graduate standing in mathematical sciences

MAT 652 Probability and Statistics II (3 Credits)
Arts & Sciences
Point and interval estimation, consistent, efficient, and sufficient statistics, Rao-Blackwellization, hypothesis testing, brief treatment of ranking and selection, decision theory.
Advisory recommendation Prereq: MAT 651 or graduate standing in mathematical sciences

MAT 653 Statistical Simulation and Nonstandard Data Analysis (3 Credits)
Arts & Sciences
Simulation and Monte Carlo techniques appropriate where statistical theory does not yet provide a solution. Design and analysis of experiments under nonstandard conditions.
Advisory recommendation Prereq: MAT 651 or graduate standing in mathematical sciences

MAT 654 Linear Models (3 Credits)
Arts & Sciences
Point estimation by least squares, regression, curve fitting, testing a linear hypothesis, analysis of variance, simple experimental designs.
Advisory recommendation Prereq: (MAT 525 and 531) or graduate standing in mathematical sciences

MAT 661 Introduction to Topology (3 Credits)
Arts & Sciences
Topological spaces, continuous mappings, compactness, connectedness, path connectedness, separation axioms, metric spaces, quotient spaces, CW complexes, the fundamental group, and the classification of 2-dimensional manifolds.
Advisory recommendation Prereq: MAT 512 or graduate standing in mathematical sciences

MAT 670 Experience Credit (1-6 Credits)
Arts & Sciences
Participation in a discipline or subject related experience. Student must be evaluated by written or oral reports or an examination. Permission in advance with the consent of the department chairperson, instructor, and dean. Limited to those in good academic standing.
Repeatable

MAT 673 Mathematical Logic II (3 Credits)
Arts & Sciences

MAT 682 Numerical Linear Algebra (3 Credits)
Arts & Sciences
Solution of linear equations. Norms and conditioning. Calculation of eigenvalues and eigenvectors. Least squares approximation and orthogonal functions. Error analysis and writing computer programs.
Advisory recommendation Prereq: MAT 511 and MAT 531

MAT 683 Methods of Numerical Analysis I (3 Credits)
Arts & Sciences
Numerical methods of interpolation, approximation, integration, and differentiation, solutions of nonlinear equations.
Advisory recommendation Prereq: MAT 512 or graduate standing in mathematical sciences

MAT 684 Methods of Numerical Analysis II (3 Credits)
Arts & Sciences
Analysis of numerical methods for approximating solutions of ordinary and partial differential equations.
Advisory recommendation Prereq: MAT 683 or graduate standing in mathematical sciences

MAT 687 Introduction to Applied Mathematics (3 Credits)
Arts & Sciences
Mathematical model building, dimensional analysis, scaling, and perturbation theory. Models selected from the natural and social sciences according to the interests of instructor and students. Examples are: planetary orbits, fluid flow, isomers in organic chemistry, biological competition, biochemical kinetics, and physiological flow.

MAT 690 Independent Study (1-6 Credits)
Arts & Sciences
In-depth exploration of a problem or problems. Individual independent study upon a plan submitted by the student. Admission by consent of supervising instructor or instructors and the department.
Repeatable

MAT 695 Fundamentals of Data Science (3 Credits)
Arts & Sciences
Double-numbered with MAT 495
Fundamental methods for data science, such as regression, linear discriminant analysis, k-nearest neighbors, support vector machine, k-means, principal component analysis, and nonlinear dimension reduction. Performance evaluation and model selection. Additional work required of graduate students.
Advisory recommendation Prereq: (MAT 331 and MAT 521) or (MAT 503 and MAT 523)
Shared Competencies: Information Literacy and Technological Agility (https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/); Scientific Inquiry and Research Skills (https://coursecatalog.syracuse.edu/shared-competencies/scientific-inquiry-and-research-skills/)

MAT 700 Selected Topics (1-6 Credits)
Arts & Sciences
Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester.
Repeatable

MAT 701 Real Variables I (3 Credits)
Arts & Sciences
Measure and integration, including basic theorems on integration and differentiation of sequences of functions; modes of convergence, product measures.
Advisory recommendation Prereq: MAT 602 or graduate standing in mathematical sciences

MAT 702 Functional Analysis I (3 Credits)
Arts & Sciences
Norms, seminorms, and inner products on linear spaces. Standard theorems on linear functionals and operations. Dual spaces and weak topologies, classical spaces and their duals. Applications.
Advisory recommendation Prereq: (MAT 631 and 661 and 701) or graduate standing in mathematical sciences

MAT 704 Differential Equations (3 Credits)
Arts & Sciences
Existence theorems for ordinary differential equations, linear differential equations and systems, Euler variational equations, typical Cauchy and boundary-value problems for partial differential equations.
Advisory recommendation Prereq: (MAT 632 and 701) or graduate standing in mathematical sciences

MAT 705 Calculus on Manifolds (3 Credits)
Arts & Sciences
Differentiable manifolds, differential forms, exterior calculus, integration over manifolds, Stokes' Theorem, other selected topics.
Advisory recommendation Prereq: (MAT 602 and MAT 632 and MAT 661) or graduate standing in mathematical sciences

MAT 712 Functions of a Complex Variable I (3 Credits)
Arts & Sciences
Cauchy theory, power series, analytic continuation, entire functions, the residue theorem, contour integration, maximum modulus theorem and applications, conformal representation. Dirichlet series, special functions.
Advisory recommendation Prereq: MAT 602 or graduate standing in mathematical sciences

MAT 721 Probability I (3 Credits)
Arts & Sciences
Measure and integration. Random variables, their distributions and transforms. Modes of convergence. Classical limit laws. Markov chains.
Advisory recommendation Prereq: (MAT 602 and MAT 701) or graduate standing in mathematical sciences

MAT 722 Probability II (3 Credits)
Arts & Sciences
Conditional expectation. Martingales. Brownian motion. Ergodic theorem. Random walks.
Advisory recommendation Prereq: MAT 721 or graduate standing in mathematical sciences

MAT 731 Rings and Modules (3 Credits)
Arts & Sciences
Submodules, factor modules, chain conditions, Hilbert basis theorem, division rings, Schur's lemma, Jacobson density theorem, semi-simple modules, socles, Jacobson radical, semi primitive rings, Artin-Wedderburn theorem, integral extensions, completions, localization.
Advisory recommendation Prereq: (MAT 631 and 632) or graduate standing in mathematical sciences

MAT 732 Homological Algebra (3 Credits)
Arts & Sciences
Projective and injective resolutions, Tor and Ext, flatness, homology, derived categories, spectral sequences.
Advisory recommendation Prereq: MAT 731 or graduate standing in mathematical sciences

MAT 733 Commutative Algebra (3 Credits)
Arts & Sciences
Localization, primary decomposition, and dimension theory; Nullstellensatz; Artin-Rees lemma and completion; integral and flat extensions; Koszul complex, Cohen-Macaulay and regular rings.
Advisory recommendation Prereq: MAT 731

MAT 737 Representations of Groups and Algebras (3 Credits)
Arts & Sciences
The course covers representations of finite groups and finite-dimensional algebras. Topics will come from: ordinary and modular representations of finite groups, Auslander-Reiten theory, representations of quivers, Koszul algebras, Hopf algebras and Frobenius algebras.
Advisory recommendation Prereq: MAT 731

MAT 738 Introduction to Algebraic Geometry (3 Credits)
Arts & Sciences
The study of the zeros of polynomials. Classical algebraic varieties in affine and projective space, followed by introduction to modern theory of sheaves, schemes, and cohomology.
Advisory recommendation Prereq: MAT 632 or graduate standing in mathematical sciences

MAT 750 Statistical Consulting (3 Credits)
Arts & Sciences
Cross-listed with STT 750
Working with real data taken from case studies, published papers, and current projects in the statistical laboratory.
Repeatable
Advisory recommendation Prereq: (MAT 525 or MAT 652) and (MAT 654 or APM 630 or MAS 766)

MAT 752 Statistical Ranking, Selection, and Multiple Comparisons (3 Credits)
Arts & Sciences
Statistical selection of the best category or population. Preference-zone and subset formulations. Multivariate preferences and populations. Applications. Recent developments, including Multiple Comparisons with the Best (MCB) and the Heteroscedastic Method (HM).
Advisory recommendation Prereq: MAT 652 or graduate standing in mathematical sciences

MAT 753 Decision Theory (3 Credits)
Arts & Sciences
Minimax theorems, completeness of the class of Bayes procedures. Invariance. Criteria for admissibility.
Advisory recommendation Prereq: MAT 525 or graduate standing in mathematical sciences

MAT 754 Sequential Analysis (3 Credits)
Arts & Sciences
General sequential decision problems, sequential probability ratio test, sequential test among three hypotheses, sequential estimation, optimal stopping, Wald's identity. Generalized SPRT's, Cox's theorem, sequential regression, functional equations, dynamic programming, sequential choice of experiments.
Advisory recommendation Prereq: MAT 525 or graduate standing in mathematical sciences

MAT 755 Multivariate Statistical Analysis (3 Credits)
Arts & Sciences
Multivariate normal distribution, conditional densities, partial correlation, multiple correlation, regression coefficients, maximum likelihood estimates, Hotelling's statistic, Wishart distribution, tests of hypotheses, and linear discriminant functions.
Advisory recommendation Prereq: MAT 525 or MAT 532 or graduate standing in mathematical sciences

MAT 757 Nonparametric Statistics (3 Credits)
Arts & Sciences
Overview of nonparametric statistics, empirical CDF, statistical functionals, density and probability function estimation, nonparametric kernel methods, nonparametric regression, conditional density estimation, bootstrap, partial linear models, single index models, and other advanced topics.
Advisory recommendation Prereq: MAT 651 and MAT 652 (or MAT 521 and MAT 525 or permission of the instructor)

MAT 758 Statistical Machine Learning (3 Credits)
Arts & Sciences
Topics in machine learning from statistical and probabilistic perspective: prediction errors and cross validation, bias-variance trade-off, regularized regression, variable selection, nonparametric regression and classification, bootstrap, trees-based methods, neural network, and other advanced topics.
Advisory recommendation Prereq: MAT 521, 525, and 651, or permission from the instructor

MAT 761 Introduction to Algebraic Topology (3 Credits)
Arts & Sciences
Fundamental group covering spaces, chain complexes, simplicial or singular homology and cohomology theory, exact sequences, and the Eilenberg-Steenrod axioms.
Advisory recommendation Prereq: (MAT 632 and MAT 661) or graduate standing in mathematical sciences

MAT 762 Algebraic Topology (3 Credits)
Arts & Sciences
Homology, cohomology ring, universal coefficient theorem, duality, homotopy, theory, selected topics.
Advisory recommendation Prereq: (MAT 632 and MAT 761) or graduate standing in mathematical sciences

MAT 771 Differential Geometry (3 Credits)
Arts & Sciences
Differential manifolds, tensor fields and mappings, differential forms and Stokes's theorem, affine connections, exponential mapping, covariant differentiation, torsion and curvature tensors, Riemannian connections, complete Riemannian manifolds, other modern topics.
Advisory recommendation Prereq: (MAT 602 and MAT 632 and MAT 661) or graduate standing in mathematical sciences

MAT 781 Numerical Optimization I (3 Credits)
Arts & Sciences
Newton methods, interior point methods, proximal point algorithms, alternating direction method of multipliers, coordinate descent method, and stochastic/randomized algorithms.
Advisory recommendation Prereq: (MAT 682 and MAT 683) or graduate standing in mathematical sciences

MAT 782 Numerical Optimization II (3 Credits)
Arts & Sciences
Continuation of MAT 781.
Advisory recommendation Prereq: MAT 781 or graduate standing in mathematical sciences

MAT 800 Topics In Analysis (3 Credits)
Arts & Sciences
Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester.
Repeatable

MAT 802 Real Variables II (3 Credits)
Arts & Sciences
Topics in real variables and measure theory, such as differentiation theory in euclidean and abstract spaces, generalized derivatives and integrals, ergodic theory, martingales, surface area.
Advisory recommendation Prereq: MAT 701 or graduate standing in mathematical sciences

MAT 804 Functional Analysis II (3 Credits)
Arts & Sciences
Abstract integration, Radon-Nikodym theorem. Representation of set functions by integrals. Ergodic theorems. Duality. Weak topologies, convex sets, and extreme points. Elements of spectral theory.
Advisory recommendation Prereq: MAT 702 or graduate standing in mathematical sciences

MAT 805 Partial Differential Equations (3 Credits)
Arts & Sciences
First-order linear equations. Hamilton, Jacobi, and Lie transformations. Classifications of second-order linear equations. Boundary- and initial-value problems. Sturm-Liouville problems and connections with integral equations. Nonlinear equations.

MAT 807 Integral Equations (3 Credits)
Arts & Sciences
Classification and examples of regular integral equations. Fredholm's theorems, Hilbert-Schmidt theory. Applications to differential equations. Nonlinear integral equations. Connections with general functional analysis.
Advisory recommendation Prereq: MAT 804 or graduate standing in mathematical sciences

MAT 812 Functions of a Complex Variable (3 Credits)
Arts & Sciences
Continuation of MAT 712
Advisory recommendation Prereq: MAT 602 or graduate standing in mathematical sciences

MAT 820 Topics in Probability (3 Credits)
Arts & Sciences
Repeatable

MAT 830 Topics in Modern Algebra (3 Credits)
Arts & Sciences
Repeatable

MAT 850 Topics in Statistics (3 Credits)
Arts & Sciences
Contents vary from semester to semester. May be repeated for credit with permission.

MAT 860 Topics in Topology (3 Credits)
Arts & Sciences
Repeatable

MAT 880 Topics in Numerical Analysis and Applied Mathematics (3 Credits)
Arts & Sciences
Repeatable

MAT 890 Advanced Seminar (1-6 Credits)
Arts & Sciences
For advanced graduate students and staff members; credit determined by extent of participation in the seminar.
Repeatable

MAT 900 Selected Topics (1-6 Credits)
Arts & Sciences
Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester.
Repeatable

MAT 990 Independent Study (1-6 Credits)
Arts & Sciences
Exploration of a problem, or problems, in depth. Individual independent study upon a plan submitted by the student. Admission by consent of supervising instructor(s) and the department.
Repeatable

MAT 997 Masters Thesis (0-6 Credits)
Arts & Sciences
Repeatable

MAT 999 Dissertation (0-15 Credits)
Arts & Sciences
Research work on a doctoral dissertation, under supervision of some member of the graduate staff. Credit depends on amount of time devoted to the work; course may be repeated up to a maximum of 30 credits.
Repeatable 15 times for 30 credits maximum