Mathematics (MATH)

MATH 101. Elementary Algebra. 3 Credits.
Fundamental operations, factoring, fractions, exponents and radicals, equations. For students with little or no background in algebra. Offered through Continuing Education. Special fee required. Does not satisfy any requirements for graduation.

MATH 103. College Algebra. 3 Credits.
Relations and functions, equations and inequalities, complex numbers; polynomial, rational, exponential and logarithmic functions; systems of equations, and matrices. Prereq: MATH 102 with a grade of C or better or placement.

MATH 104. Finite Mathematics. 3 Credits.
Systems of linear equations and inequalities, matrices, linear programming, mathematics of finance, elementary probability and descriptive statistics. Prereq: MATH 102 or placement.

MATH 105. Trigonometry. 3 Credits.
Angle measure, trigonometric and inverse trigonometric functions, trigonometric identities and equations, polar coordinates and applications. Prereq: MATH 103 or placement. Credit awarded only for MATH 105 or MATH 107, not both.

MATH 107. Precalculus. 4 Credits.
Equations and inequalities; polynomial, rational, exponential, logarithmic and trigonometric functions; inverse trigonometric functions; algebraic and trigonometric methods commonly needed in calculus. An expedited, combined offering of MATH 103 and MATH 105. Prereq: Placement. Credit awarded only for MATH 105 or MATH 107, not both.

MATH 128. Introduction to Linear Algebra. 1 Credit.
Systems of linear equations, row operations, echelon form, matrix operations, inverses, and determinants. Prereq: MATH 105 or MATH 107. Credit awarded only for MATH 128 or MATH 129, not both.

MATH 129. Basic Linear Algebra. 2 Credits.
Includes content of MATH 128 with the addition of vectors in n-space, subspaces, homogeneous systems, linear independence, rank, and dimension. Prereq: MATH 105 or MATH 107. Credit awarded only for MATH 128 or MATH 129, not both.

MATH 144. Mathematics for Business. 4 Credits.
Mathematics of finance, linear programming and its applications in business, limits, continuity, derivatives, implicit and logarithmic differentiation, higher order derivatives, optimization and extrema, partial differentiation, extreme values of functions of two variables. Prereq: MATH 103, MATH 107 or placement exam. Credit awarded only for MATH 144 or MATH 146, not both.

MATH 146. Applied Calculus I. 4 Credits.
Limits, derivatives, integrals, exponential and logarithmic functions and applications. Prereq: MATH 103, MATH 107, or placement. Credit awarded only for MATH 144 or MATH 146, not both.

MATH 147. Applied Calculus II. 4 Credits.
Definite integrals, trigonometry, introduction to differential equations, infinite sequences and series, probability and applications. Prereq: MATH 146.

MATH 165. Calculus I. 4 Credits.
Limits, continuity, differentiation, Mean Value Theorem, integration, Fundamental Theorem of Calculus and applications. Prereq: MATH 105, MATH 107, or placement.

MATH 166. Calculus II. 4 Credits.
Applications and techniques of integration; polar equations; parametric equation; sequences and series, power series. Prereq: MATH 165.

MATH 194. Individual Study. 1-5 Credits.

MATH 196. Field Experience. 1-15 Credits.

MATH 199. Special Topics. 1-5 Credits.

MATH 259. Multivariate Calculus. 3 Credits.
Functions of several variables, vectors in two and three variables, partial derivatives, surfaces and gradients, tangent planes, differentials, chain rule, optimization, space curves, and multiple integrals. Prereq: MATH 166. Credit awarded only for MATH 259 or MATH 265, not both.

MATH 265. Calculus III. 4 Credits.
Multivariate and vector calculus including partial derivatives, multiple integration, applications, line and surface integrals, Green's Theorem, Stoke's Theorem, and Divergence Theorem. Prereq: MATH 166. Credit awarded only for MATH 259 or MATH 265, not both.

MATH 266. Introduction to Differential Equations. 3 Credits.
Solution of elementary differential equations by elementary techniques. Laplace transforms, systems of equations, matrix methods, numerical techniques, and applications. Prereq: MATH 259 or MATH 265. Coreq: MATH 128, MATH 129, or MATH 429.

MATH 270. Introduction to Abstract Mathematics. 3 Credits.
Sets, symbolic logic, propositions, quantifiers, methods of proof, relations and functions, equivalence relations, math induction and its equivalents, infinite sets, cardinal numbers, number systems. Prereq: MATH 166.

MATH 291. Seminar. 1-3 Credits.

MATH 294. Individual Study. 1-5 Credits.

MATH 299. Special Topics. 1-5 Credits.

MATH 329. Intermediate Linear Algebra. 3 Credits.
Vector spaces over real and complex numbers, matrices, determinants, linear transformations, eigenvalues and eigenvectors, Cayley-Hamilton Theorem, inner product spaces, selected topics and applications. Prereq: MATH 129 and MATH 165.

MATH 346. Metric Space Topology. 3 Credits.
Various metrics on Euclidean spaces, metric spaces, open and closed sets, limit points and convergence, Bolzano Weierstrass Theorem, (uniformly) continuous functions, connected spaces, compact spaces and the Heine Borel Theorem, sequence of functions. Prereq: MATH 270.

MATH 374. Special Problems In Mathematics. 1 Credit.
Diverse and challenging mathematical problems are considered with the intent of preparing the student for the Putnam Mathematics competition. May be repeated for credit. Pass/Fail only. Prereq: MATH 270.

MATH 376. Actuarial Exam Study. 1 Credit.
Selected material from calculus, linear algebra, numerical analysis, and other areas that appear on national actuarial exams. May be repeated for credit. Pass/Fail only. Prereq: MATH 266 and MATH 429.

MATH 379. Study Tour Abroad. 1-6 Credits.

MATH 391. Seminar. 1-3 Credits.

MATH 392. Study Abroad. 1-15 Credits.

MATH 394. Individual Study. 1-5 Credits.

MATH 399. Special Topics. 1-5 Credits.

MATH 420. Abstract Algebra I. 3 Credits.
Groups, permutations, quotient groups, homomorphisms, rings, ideals, integers. Prereq: MATH 270. {Also offered for graduate credit - see MATH 620.}.

MATH 421. Abstract Algebra II. 3 Credits.
Division rings, integral domains, fields, field extensions, Galois Theory. Prereq: MATH 420. {Also offered for graduate credit - see MATH 621.}.

MATH 429. Linear Algebra. 3 Credits.
Vector spaces, linear transformations, eigenvalues and eigenvectors, canonical forms, inner product spaces, and selected applications. Prereq: MATH 270. {Also offered for graduate credit - see MATH 629.}.

MATH 430. Graph Theory. 3 Credits.
Graphs and directed graphs, graph models, subgraphs, isomorphisms, paths, connectivity, trees, networks, cycles, circuits, planarity, Euler's formula, matchings, bipartite graphs, colorings, and selected advanced topics. Prereq: MATH 270. {Also offered for graduate credit - see MATH 630.}.

MATH 436. Combinatorics. 3 Credits.
Recurrence relations, formal power series, generating functions, exponential generating functions, enumeration, binomial coefficients and identities, hypergeometric functions, Ramsey theory, Sterling and Eulerian numbers. Prereq: MATH 270. {Also offered for graduate credit - see MATH 636.}.

MATH 440. Axiomatic Geometry. 3 Credits.
Hilbert's axioms for Euclidean geometry, projective geometry, history of parallel axiom, hyperbolic geometry, elliptic geometry. Prereq: MATH 270. {Also offered for graduate credit - see MATH 640.}.

MATH 445. Differential Geometry. 3 Credits.
Basic properties of curves and surfaces, Frenet equations, the Gauss Map, intrinsic geometry of surfaces, geodesics, Gauss-Bonnet Theorem, and applications. Prereq: MATH 265 and MATH 270. {Also offered for graduate credit - see MATH 645.}.

MATH 446. Introduction to Topology. 3 Credits.
Topology of Euclidean space, metric spaces, topological spaces, bases and neighborhoods, Hausdorff property, continuity, homeomorphisms and embeddings, connectivity, and compactness. Prereq: MATH 270. {Also offered for graduate credit - see MATH 646.}.

MATH 450. Real Analysis I. 3 Credits.
This course will cover sequences and convergence in R, continuity, uniform convergence, compactness, fixed point theorems, differentiability and other selected topics. Prereq: MATH 270. {Also offered for graduate credit - see.MATH 650.}.

MATH 451. Real Analysis II. 3 Credits.
Riemann integration, spaces of continuous functions, convergence theorems, multiple integration and Fubini's Theorem and selected topics. Prereq: MATH 450.{Also offered for graduate credit - see MATH 651.}.

MATH 452. Complex Analysis. 3 Credits.
Complex number systems, analytic and harmonic functions, elementary conformal mapping, integral theorems, power series, Laurent series, residue theorem, and contour integral. Prereq: MATH 265 and MATH 270. {Also offered for graduate credit - see MATH 652.}.

MATH 460. Intensive Mathematica. 1 Credit.
Thorough overview of the general purpose mathematical software MATHEMATICA: numerical and symbolic calculations for algebra and linear algebra, single and multivariable calculus, ordinary and partial differential equations, 2D- and 3D-graphics, animation, word processing. Prereq: MATH 259 or MATH 265. {Also offered for graduate credit - see MATH 660.}.

MATH 472. Number Theory. 3 Credits.
Properties of integers, number theoretic functions, quadratic residues, continued fractions, prime numbers and their distribution, primitive roots. Prereq: MATH 270. {Also offered for graduate credit - see MATH 672.}.

MATH 473. Cryptology. 3 Credits.
Cryptography and cryptanalysis of ciphers. Discrete logarithms, Diffie-Hellman key exchange, the RSA cryptosystem, elliptic curve cryptography, and selected topics. Prereq: MATH 420 or MATH 472. {Also offered for graduate credit - see MATH 673.}.

MATH 478. History of Mathematics. 3 Credits.
Historical considerations emphasizing the source of mathematical ideas, growth of mathematical knowledge, and contributions of some outstanding mathematicians. Prereq: MATH 270. {Also offered for graduate credit - see MATH 678.}.

MATH 480. Applied Differential Equations. 3 Credits.
Method of power series and method of Frobenius, oscillation theorems, special functions (Bessel functions and Legendre functions), linear systems including the exponential matrix. Sturm-Liouville and phase plane analysis as time permits. Prereq: MATH 266. {Also offered for graduate credit - see MATH 680.}.

MATH 481. Fourier Analysis. 3 Credits.
Discrete and continuous Fourier transforms, Fourier series, convergence and inversion theorems, mean square approximation and completeness, Poisson summation, Fast-Fourier transform. Prereq: MATH 265. {Also offered for graduate credit - see MATH 681.}.

MATH 483. Partial Differential Equations. 3 Credits.
First and second order partial differential equations, classification, examples, solution methods for the wave, diffusion, and Laplace equations, causality and energy, boundary value problems, separation of variables, Green's identities, Green's functions. Prereq: MATH 266. {Also offered for graduate credit - see MATH 683.}.

MATH 484. Mathematical Methodsof Biological Processes. 3 Credits.
This course provides an introduction to mathematical methods in biology. Prereq: MATH 266. {Also offered for graduate credit - see MATH 684.}.

MATH 488. Numerical Analysis I. 3 Credits.
Numerical solution of nonlinear equations, interpolation, numerical integration and differentiation, numerical solution of initial value problems for ordinary differential equations. Prereq: MATH 266. {Also offered for graduate credit - see MATH 688.}.

MATH 489. Numerical Analysis II. 3 Credits.
Numerical solutions of linear and nonlinear systems, eigenvalue problems for matrices, boundary value problems for ordinary differential equations, selected topics. Prereq: MATH 429, MATH 488. {Also offered for graduate credit - see MATH 689.}.

MATH 491. Seminar. 1-5 Credits.

MATH 492. Study Abroad. 1-15 Credits.

MATH 493. Undergraduate Research. 1-5 Credits.

MATH 494. Individual Study. 1-5 Credits.

MATH 496. Field Experience. 1-15 Credits.

MATH 499. Special Topics. 1-5 Credits.

MATH 620. Abstract Algebra I. 3 Credits.
Groups, permutations, quotient groups, homomorphisms, rings, ideals, integers. {Also offered for undergraduate credit - see MATH 420.}.

MATH 621. Abstract Algebra II. 3 Credits.
Division rings, integral domains, fields, field extensions, Galois Theory. Prereq: MATH 620. {Also offered for undergraduate credit - see MATH 421.}.

MATH 629. Linear Algebra. 3 Credits.
Vector spaces, linear transformations, eigenvalues and eigenvectors, canonical forms, inner product spaces, and selected applications. {Also offered for undergraduate credit - see MATH 429.}.

MATH 630. Graph Theory. 3 Credits.
Graphs and directed graphs, graph models, subgraphs, isomorphisms, paths, connectivity, trees, networks, cycles, circuits, planarity, Euler's formula, matchings, bipartite graphs, colorings, and selected advanced topics. {Also offered for undergraduate credit - see MATH 430.}.

MATH 636. Combinatorics. 3 Credits.
Recurrence relations, formal power series, generating functions, exponential generating functions, enumeration, binomial coefficients and identities, hypergeometric functions, Ramsey theory, Sterling and Eulerian numbers. {Also offered for undergraduate credit - see MATH 436.}.

MATH 640. Axiomatic Geometry. 3 Credits.
Hilbert's axioms for Euclidean geometry, projective geometry, history of parallel axiom, hyperbolic geometry, elliptic geometry. {Also offered for undergraduate credit - see MATH 440.}.

MATH 645. Differential Geometry. 3 Credits.
Basic properties of curves and surfaces, Frenet equations, the Gauss Map, intrinsic geometry of surfaces, geodesics, Gauss-Bonnet Theorem, and applications. {Also offered for undergraduate credit - see MATH 445.}.

MATH 646. Introduction to Topology. 3 Credits.
Topology of Euclidean space, metric spaces, topological spaces, bases and neighborhoods, Hausdorff property, continuity, homeomorphisms and embeddings, connectivity, and compactness. {Also offered for undergraduate credit - see MATH 446.}.

MATH 650. Real Analysis I. 3 Credits.
Sequences and convergence in R, continuity, uniform convergence, compactness, fixed point theorems, differentiability and other selected topics. {Also offered for undergraduate credit - see MATH 450.}.

MATH 651. Real Analysis II. 3 Credits.
Riemann integration, spaces of continuous functions, convergence theorems, multiple integration and Fubini's Theorem and selected topics. Prereq: MATH 650. {Also offered for undergraduate credit - see MATH 451.}.

MATH 652. Complex Analysis. 3 Credits.
Complex number systems, analytic and harmonic functions, elementary conformal mapping, integral theorems, power series, Laurent series, residue theorem, and contour integral. {Also offered for undergraduate credit - see MATH 452.}.

MATH 660. Intensive Mathematica. 1 Credit.
Thorough overview of the general purpose mathematical software MATHEMATICA: numerical and symbolic calculations for algebra and linear algebra, single and multivariable calculus, ordinary and partial differential equations, 2D- and 3D-graphics, animation, word processing. {Also offered for undergraduate credit - see MATH 460.}.

MATH 672. Number Theory. 3 Credits.
Properties of integers, number theoretic functions, quadratic residues, continued fractions, prime numbers and their distribution, primitive roots. {Also offered for undergraduate credit - see MATH 472.}.

MATH 673. Cryptology. 3 Credits.
Cryptography and cryptanalysis of ciphers. Discrete logarithms, Diffie-Hellman key exchange, the RSA cryptosystem, elliptic curve cryptography, and selected topics. {Also offered for undergraduate credit - see MATH 473.}.

MATH 678. History of Mathematics. 3 Credits.
Historical considerations emphasizing the source of mathematical ideas, growth of mathematical knowledge, and contributions of some outstanding mathematicians. {Also offered for undergraduate credit - see MATH 478.}.

MATH 680. Applied Differential Equations. 3 Credits.
Method of power series and method of Frobenius, oscillation theorems, special functions (Bessel functions and Legendre functions), linear systems including the exponential matrix. Sturm-Liouville and phase plane analysis as time permits. {Also offered for undergraduate credit - see MATH 480.}.

MATH 681. Fourier Analysis. 3 Credits.
Discrete and continuous Fourier transforms, Fourier series, convergence and inversion theorems, mean square approximation and completeness, Poisson summation, Fast-Fourier transform. {Also offered for undergraduate credit - see MATH 481.}.

MATH 683. Partial Differential Equations. 3 Credits.
First and second order partial differential equations, classification, examples, solution methods for the wave, diffusion, and Laplace equations, causality and energy, boundary value problems, separation of variables, Green's identities, Green's functions. {Also offered for undergraduate credit - see MATH 483.}.

MATH 684. Mathematical Methods of Biological Processes. 3 Credits.
This course provides an introduction to mathematical methods in biology. {Also offered for undergraduate credit - see MATH 484.}.

MATH 688. Numerical Analysis I. 3 Credits.
Numerical solution of nonlinear equations, interpolation, numerical integration and differentiation, numerical solution of initial value problems for ordinary differential equations. {Also offered for undergraduate credit - see MATH 488.}.

MATH 689. Numerical Analysis II. 3 Credits.
Numerical solutions of linear and nonlinear systems, eigenvalue problems for matrices, boundary value problems for ordinary differential equations, selected topics. Prereq: MATH 629, MATH 688. {Also offered for undergraduate credit - see MATH 489.}.

MATH 690. Graduate Seminar. 1-3 Credits.

MATH 696. Special Topics. 1-5 Credits.

MATH 720. Algebra I. 3 Credits.
Graduate level survey of algebra: groups, rings, fields, Galois theory, and selected advanced topics. Prereq: MATH 621.

MATH 721. Algebra II. 3 Credits.
Graduate level survey of algebra: groups, rings, fields, Galois theory, and selected advanced topics. Prereq: MATH 621.

MATH 726. Homological Algebra. 3 Credits.
An overview of the techniques of homological algebra. Topics covered will include categories and functors, exact sequences, (co)chain complexes, Mayer-Vietoris sequences, TOR and EXT. Applications to other fields will be stressed. Prereq: MATH 621.

MATH 732. Introduction to Bioinformatics. 3 Credits.
An introduction to the principles of bioinformatics including information relating to the determination of DNA sequencing. Prereq: STAT 661. Cross-listed with CSCI 732 and STAT 732.

MATH 746. Topology I. 3 Credits.
Topological spaces, convergence and continuity, separation axioms, compactness, connectedness, metrizability, fundamental group and homotopy theory. Advanced topics may include homology theory, differential topology, three-manifold theory and knot theory. Prereq: MATH 646.

MATH 747. Topology II. 3 Credits.
Topological spaces, convergence and continuity, separation axioms, compactness, connectedness, metrizability, fundamental group and homotopy theory. Advanced topics may include homology theory, differential topology, three-manifold theory and knot theory. Prereq: MATH 646.

MATH 750. Analysis. 3 Credits.
Lebesgue and general measure and integration theory, differentiation, product spaces, metric spaces, elements of classical Banach spaces, Hilbert spaces, and selected advanced topics. Prereq: MATH 651.

MATH 752. Complex Analysis. 3 Credits.
Analytic and harmonic functions, power series, conformal mapping, contour integration and the calculus of residues, analytic continuation, meromorphic and entire functions, and selected topics. Prereq: MATH 651.

MATH 754. Functional Analysis. 3 Credits.
Normed spaces, linear maps, Hahn-Banach Theorem and other fundamental theorems, conjugate spaces and weak topology, adjoint operators, Hilbert spaces, spectral theory, and selected topics. Prereq: MATH 751.

MATH 760. Ordinary Differential Equations I. 3 Credits.
Existence, uniqueness, and extensibility of solutions to initial value problems, linear systems, stability, oscillation, boundary value problems, and selected advanced topics. Prereq: MATH 650 or MATH 680.

MATH 782. Mathematical Methods in Physics I. 3 Credits.
Review of practical mathematical methods routinely used by physicists, including applications. Focus on differential equations, variational principles, and other selected topics. Cross-listed with PHYS 752.

MATH 783. Mathematical Methods in Physics II. 3 Credits.
Tensor analysis, matrices and group theory, special relativity, integral equations and transforms, and selected advanced topics. Prereq: MATH 629 and MATH 652. Cross-listed with PHYS 753.

MATH 784. Partial Differential Equations I. 3 Credits.
Classification in elliptic, parabolic, hyperbolic type; existence and uniqueness for second order equations; Green's functions, and integral representations; characteristics, nonlinear phenomena. Prereq: MATH 650 or MATH 683.

MATH 790. Graduate Seminar. 1-3 Credits.

MATH 791. Temporary/Trial Topics. 1-5 Credits.

MATH 792. Specialized Studies for K-12 Teachers. 1-5 Credits.
Study of contemporary issues relevant to the K-12 education environment. Graded "S" or "U" and non-didactic by default. Letter grading may be requested. Contact the Graduate School to request didactic credit.

MATH 793. Individual Study/Tutorial. 1-5 Credits.

MATH 796. Special Topics. 1-5 Credits.

MATH 797. Master's Paper. 1-3 Credits.

MATH 798. Master's Thesis. 1-10 Credits.

MATH 810. Research in the Teaching of University Mathematics. 3 Credits.
This course will cover fundamental topics in mathematics education research including: research design, fundamental research areas, and the interconnection between research and classroom practices.

MATH 824. Topics in Commutative Algebra. 3 Credits.
Topics vary each time the course is offered and may include: dimension theory, integral dependence, factorization, regular rings, Cohen-Macaulay rings, Gorenstein rings. May be repeated for credit with change in subtopic. Prereq: MATH 721.

MATH 825. Theory Of Rings. 3 Credits.
The ideal theory of commutative rings, structure of (non-commutative) rings, and selected advanced topics. Prereq: MATH 721.

MATH 830. Graph Theory. 3 Credits.
Graduate-level survey of graph theory: paths, connectivity, trees, cycles, planarity, genus, Eulerian graphs, Hamiltonian graphs, factorizations, tournaments, embedding, isomorphism, subgraphs, colorings, Ramsey theory, girth. Prereq: MATH 630.

MATH 836. Discrete Mathematics. 3 Credits.
Combinatorial reasoning, generating functions, inversion formulae. Topics may include design theory, finite geometry, Ramsey theory, and coding theory. Advanced topics may include cryptography, combinatorial group theory, combinatorial number theory, algebraic combinatorics, (0,1)-matrices, and finite geometry. Prereq: MATH 636.

MATH 849. Topics in Geometry & Topology. 3 Credits.
Advanced topics in Geometry and/or Topology. Topics vary but may include: differential geometry, K-theory, knot theory, or noncommutative geometry. May be repeated for credit with change in subtopic. Prereq: MATH 721, MATH 751.

MATH 856. Dynamical Systems. 3 Credits.
A study of basic notions of topological and symbolic dynamics. Introduction to measurable dynamics and ergodic theory. Ergodicity, mixing and entropy of dynamical systems. Prereq: MATH 750.

MATH 857. Topics in Functional Analysis. 3 Credits.
Maximal monotone operators and the Hille-Yosida theorem, Sobolev spaces in dimension one and applications, Sobolev spaces in higher dimensions, extension operators, Sobolev embedding theorems, Poincare inequality, duality. May be repeated for credit with change in subtopic. Prereq: MATH 750. Co-req: MATH 751.

MATH 861. Ordinary Differential Equations II. 3 Credits.
Existence, uniqueness, and extendibility of solutions to initial value problems, linear systems, stability, oscillation, boundary value problems, difference equations, and selected advanced topics. Prereq: MATH 760.

MATH 862. Integral Equations. 3 Credits.
Existence and uniqueness of solutions of Fredholm and Volterra integral equations, Fredholm Theory, singular integral equations, and selected advanced topics. Prereq: MATH 651.

MATH 864. Calculus Of Variations. 3 Credits.
Variational techniques of optimization of functionals, conditions of Euler, Weierstrass, Legendre, Jacobi, Erdmann, Pontryagin Maximal Principle, applications, and selected advanced topics. Prereq: MATH 651.

MATH 867. Topics in Applied Mathematics. 3 Credits.
Topics will vary and may include: Optimal Control, Robust Control, Stability Analysis, Mathematics of Networks, Models in Biology, Levy Processes, Asymptotic Expansions. May be repeated for credit with change in subtopic. Prereq: MATH 651 or MATH 680.

MATH 878. Modern Probability Theory. 3 Credits.
Probability theory presented from the measure theoretic perspective. Emphasis on various types of convergence and limit theorems. Discussion of random walks, conditional expectations, and martingales. Prereq: STAT 768 or MATH 750. Cross-listed with STAT 778.

MATH 880. Methods of Optimization. 3 Credits.
Elements of convex analysis, constrained and unconstrained multi-dimensional linear and nonlinear optimization theory and algorithms, convergence properties and computational complexity. Prereq: CSCI 653. Cross-listed with CSCI 880.

MATH 881. Mathematical Control Theory. 3 Credits.
Standard optimal control and optimal estimation problems; duality; optimization in Hardy space; robust control design. Prereq: MATH 650.

MATH 885. Partial Differential Equations II. 3 Credits.
Nonlinear partial differential equations, Non-variational techniques, Hamilton-Jacobi equations, Riemann invariants, Entropy/entropy-flux pairs, selected advanced topics. Prereq: MATH 784.

MATH 888. Numerical Analysis. 3 Credits.
Numerical solutions to partial differential and integral equations, error analysis, stability, acceleration of convergence, numerical approximation, and selected advanced topics. Prereq: MATH 689.

MATH 899. Doctoral Dissertation. 1-15 Credits.

MATH 98. Intermediate Algebra. 3 Credits.
Properties of the real number system, factoring, linear and quadratic equations, functions, polynomial and rational expressions, inequalities, systems of equations, exponents, and radicals. Offered through Continuing Education. Special fee required. Does not satisfy any requirements for graduation.