# MATH: MATHEMATICS (MATH)

**MATH 501. Geometry. (3 Credits)**
Points and lines connected with a triangle; circle properties; collinearity and concurrence; Menelaus' Theorem; Cevas' Theorem; Pappus' Theorem; Desargues Theorem; transformations; introduction to inversive and projective geometry. Prerequisite: Admission to the program.

**MATH 505. Number & Number Sense. (3 Credits)**
This course examines number systems and operations, elementary number theory, concepts of integers and whole numbers including selected number sets, basic counting principles, and computational algorithms in a problem-solving environment. Appropriate use of technology and manipulatives, NCTM-aligned teaching methodology, and multiple means of authentic assessment will be incorporated into this course that emphasizes the equity principle, and the connections and representations standards. Content delivery will include student investigations and hands-on activities.

**MATH 506. Geometry and Measurement. (3 Credits)**
This course examines properties and relationships of polygons, transformational geometry, coordinate geometry, constructions, deductive & inductive reasoning, the process of measurement through geometric investigations, and an introduction to matrix Algebra, fractals and non-Euclidean geometries in a problem-solving environment. Appropriate use of technology and manipulatives, NCTM-aligned teaching methodology, and multiple means of authentic assessment will be incorporated into this course that emphasizes the equity principle and the connections and representations standards. Content delivery will include student investigations and hands-on activities.

**MATH 507. Pattern Func Algebra Reason. (3 Credits)**
The course examines structures of familiar number systems to include basic algebraic operations, linear and quadratic equations, linear systems of equations and inequalities, algebraic and trigonometric functions in the context of modeling and various representations of functions (graphical, tabular, and symbolic) in a problem-solving environment. Appropriate use of technology and manipulatives, NCTM-aligned teaching methodology, and multiple means of authentic assessment will be incorporated into this course that emphasizes the equity principle and the connections and representations standards. Content delivery will include student investigations and hands-on activities.

**MATH 510. Discrete Mathematics. (3 Credits)**
Counting techniques; Pigeon-hole principle; Binominal coefficients; Principle of inclusion-exclusion; generating functions; Stirling and Catalan numbers; permutations and graphs. Prerequisite: Admission to the program.

**MATH 511. Coding Theory. (3 Credits)**
Linear codes; non-linear codes; B.C.H. codes; dual codes and their weight distributions; perfect codes and cyclic codes; additional topics drawn from Reed-Solomon codes; Justessen codes; M.D.S. codes; Reed-Muller codes; Golay codes; self-dual codes and invariant theory. Prerequisite: MATH 325 or equivalent.

**MATH 512. Cryptography & Cmptr Security. (3 Credits)**
Public key cryptography; classical applications of finite fields and number theory; classical cryptography and cryptoanalysis; monoalpabetic and polyalphabetic ciphers; Shannon's theory of secrecy; modern private-key cryptosystems such as DES, and public-key cryptosystems such as RSA. (Cross listed as CSCI 580). Prerequisite: MATH 325 or equivalent.

**MATH 520. Algebra I. (3 Credits)**
Group; subgroups; Lagrange's Theorem; normal subgroups; quotient groups; homomorphisms; direct products; fundamental Theorem of finite abelian groups; group actions; Cayley's Theorem; conjugacy classes and the class equation; Sylow Theorems; isomorphism theorems. Prerequisite: MATH 425 or equivalent.

**MATH 521. Algebra II. (3 Credits)**
Rings; integral domains; introduction to fields; ring homomorphisms; ideals; polynomial rings; Euclidean domains; unique factorization domains; field Theory; geometric constructions; Galois theory. Prerequisites: MATH 520.

**MATH 525. Linear Algebra. (3 Credits)**
Linear transformations; solving linear equations; LU decomposition; determinants and relation to solving linear equations; eigenvalues and eigenvectors; Jordan canonical form; Schur form; special classes of matrices: normal; symmetric; Hermitian; orthogonal; unitary; Jacobi; Special properties of these matrices; spectral theory for normal matrices; positive matrices; inner product spaces; orthogonality. Prerequisite: MATH 325 or equivalent.

**MATH 530. Real Analysis I. (3 Credits)**
Functions of bounded variation; Lebesgue measure; differentiation and integration; Lp spaces; introduction to Banach and Hilbert spaces. Prerequisite: MATH 401 or equivalent.

**MATH 531. Real Analysis II. (3 Credits)**
Abstract measures; mappings of measure spaces; integration sets and products spaces; the Fubini, Torelli and Radon-Nikodyn theorems; the Riesz-Fischer representation theorem; Haar measures on locally compact groups. Prerequisite: MATH 530.

**MATH 532. Complex Analysis. (3 Credits)**
Linear fractional transformations; conformal mapping; holomorphic functions; Cauchy's theorem; properties of holomorphic functions; argument principle; residues; power series; Laurent series; meromorphic functions; Riemann mapping theorem; Mittag-Leffler's theorem; Weierstrass' theorem. Prerequisite: MATH 432 or equivalent.

**MATH 533. Functional Analysis. (3 Credits)**
Banach spaces; Hilbert spaces; fundamental theorems for Banach and Hilbert spaces; dual spaces; bounded inverse theorems; uniform boundedness principle and its applications; strong and weak convergence; spectral theory of linear operators in normed spaces; compact linear operator on normed spaces and their spectrum. Prerequisite: MATH 530.

**MATH 540. Numerical Analysis. (3 Credits)**
Approximations and interpolation; propagation of errors; numerical differentiation and integration; solutions of equations; Newton's method; solutions of differential equations and initial value problems; Runge-Kutta and predictor-corrector methods. Prerequisite: MATH 452 or equivalent.

**MATH 545. General Topology. (3 Credits)**
Foundations and fundamental concepts of point-set topology; topological spaces; convergence; connected sets; compactness; product spaces; quotient spaces; function spaces; separation properties; metrization theorems; mappings and compactifications; Homotopy and fundamental groups. Prerequisite: MATH 445 or equivalent.

**MATH 546. Difference Equations & Appl. (3 Credits)**
Topics include difference calculus; linear difference equations; autonomous systems of difference equations; linear periodic systems; stability analysis and Liapunov method; Z-transform; asymptotic behavior of difference equations. Prerequisites: MATH 360 or equivalent; MATH 325 or equivalent.

**MATH 548. Differential Equations. (3 Credits)**
Existence and uniqueness for systems; linear systems; fundamental matrix solutions; matrix exponential; nonlinear systems; plane autonomous systems and introduction to stability; Poincare-Bendixson theorem. Prerequisite: MATH 350 or equivalent.

**MATH 552. Partial Differentiation Equati. (3 Credits)**
Preliminaries from ODE and Calculus; methods of solution of partial differential equations of the first order; classification of partial differential equations; elliptic, hyperbolic, and parabolic equations; Sturm-Liouville problems; non-homogeneous equations; potential theory; techniques of solving various partial differential equations; Cauchy problem; Dirichlet and Neumann problems; Green's function; Solutions by eigenfunction expansion method; Applications. Prerequisites: MATH 350.

**MATH 554. Math Modeling Life Sciences. (3 Credits)**
Study of a variety of mathematical and computational methods used to describe and understand natural phenomena and their dynamics in biological systems; topics include difference equations; ordinary and partial differential equations; stochastic processes; and computer simulation with computer algebra systems. Prerequisite: MATH 548 or MATH 546.

**MATH 560. Algebraic & Numerical Comptuta. (3 Credits)**
Basic techniques of algorithm design; fundamental computations with polynomials; Fast Fourier transform; polynomial evaluation and interpolation; power series manipulation; fundamental computations with general and special structured matrices and correlation to polynomials; fast algorithms and correlation between algebraic and numerical computations in algorithm design. Prerequisites: MATH 325 and MATH 261.

**MATH 562. Mathematical Statistics. (3 Credits)**
Univariate and multivariate distribution theory; generating function; inequalities in statistics; order statistics; estimation theory; likelihood; sufficiency; efficiency; maximum likelihood testing hypotheses; likelihood ratio; confidence and prediction interval; Bayesian estimation and testing; basic decision theory. Prerequisite: MATH 261 or equivalent.

**MATH 570. Number Theory. (3 Credits)**
Arithmetic functions; divisibility and prime factorization; residue classes; congruence; the prime number theorem; primes in arithmetic progression; quadratic reciprocity law; the arithmetic of quadratic fields; Diophantine equations; continued fractions, approximations and sieves. Prerequisite: MATH 425 or equivalent.

**MATH 579. History of Mathematics. (3 Credits)**
Chronological and topical history of mathematics, mathematics education and related areas as they parallel ancient and modern world history and U.S. history. The influence of mathematics as a derivative of philosophy and science. The origins of mathematical symbols and the development of a deductive system used as structures of knowledge in other disciplines. Specific topics include: women in mathematics, blacks in mathematics, multicultural development of mathematics, the development of calculating devices, using math history in multidisciplinary teaching.

**MATH 580. Geometry for Teachers. (3 Credits)**
Selected topics in geometry for teachers of mathematics. Topics include deductive logic, incidence geometry, abstract deductive systems, induction, convexity and separation, geometric inequalities, congruence, similarity, parallelism, Euclidean and non-Euclidean geometries.

**MATH 581. Modern Algebra. (3 Credits)**
Topics in modern algebra including sets, mappings, equivalence relations, groups, groups homomorphism, isomorphism, rings, integral domains, and fields.

**MATH 582. Real Analysis for Teachers. (3 Credits)**
Real number theory; elementary and advanced set theory including open and closed sets, compacts sets and bounded sets; methodology of writing mathematical proofs including mathematical induction and proof of calculus theorems; introduction to sequence and series; convergence tests.

**MATH 583. Problem Solving in Math. (3 Credits)**
Students will employ various heuristics while engage in problem solving. Student will pose problems appropriate for middle school and high school students. Problem topics will be selected from arithmetic, basic algebra, geometry, trigonometry, analytic geometry, functions and their graphs, calculus, probability and statistics, discrete mathematics and linear algebra. Mathematical reasoning and mathematical modeling will be emphasized. Appropriate use of technology will be discussed, modeled, and used during the problem-solving process.

**MATH 584. Calculus for Teachers I. (3 Credits)**
Inequalities, absolute values, limits and rates of changes, continuity, derivatives, applications of differentiation, integers, applications of integration, inverse functions and techniques of integration. Topics are treated from an advanced point of view for teachers of mathematics.

**MATH 585. Calculus for Teachers II. (3 Credits)**
Integration techniques, polynomial approximation and series, polar coordinates, conics, multivariate calculus, parametric equations, and vectors. Course is designed to make connections between advanced calculus topics and the teaching of AP calculus. Prerequisite: MAED 575.

**MATH 586. Discrete Math for Teachers. (3 Credits)**
The terminology, concepts, and techniques of some areas of discrete mathematics applicable to middle and high school teaching. Logic, proof techniques, recursion, set theory and enumeration, relations functions, and introduction code and graph theory. Course is designed to make connections between discrete mathematics topics and the teaching of discrete mathematics in middle and high school.

**MATH 587. Linear Algebra for Teachers. (3 Credits)**
Vectors, matrix operations, systems of linear equations, determinants, systems of linear inequalities and linear transformations. Topics are treated from an advanced point of view for teachers of mathematics. Use knowledge of mathematics to select and use appropriate technological tools, such as but not limited to, spreadsheets, dynamic graphing tools, computer algebra systems, dynamic statistical packages, graphing calculators, data-collection devices, and presentation software.

**MATH 588. Differential Geomertry. (3 Credits)**
Differential manifolds; tensors; affine connections; and Riemannian manifolds; submanifolds; variation of the length integral; the Morse index theorem. Prerequisites: MATH 445, MATH 401, or equivalent.

**MATH 590. Graph Theory. (3 Credits)**
Basic concepts of graphs and digraphs; Eulerian and Hamiltonian graphs; trees and distances; matchings and factors; connectivity; colorings; planar graphs; flows and networks; extremal graph theory. Prerequisite: MATH 490 or equivalent.

**MATH 592. Optimization Theory. (3 Credits)**
Convexity; duality; quadratic forms and matrix factorization; theory of optimization with and without constraints; Lagrange functions; Kuhn-Tucker theory; methods of optimization without constraints; line search; descent methods; Newton methods; conjugate directions; non-linear least squares; methods of optimization with constraints: linear optimization; the simplex and other methods; active sets; quadratic programming; optimization with linear constraints; general non-linear optimization. Prerequisite: MATH 392 or equivalent.

**MATH 598. Comprehensive Exam. (0 Credits)**
MATH 598 COMPREHENSIVE EXAM - 0 SEMESTER HOURS F, SP A zero-credit course designed for candidates eligible for the Master of Science Degree in Mathematics who have selected the non-thesis option track. Students will be able to register for this course and take the comprehensive exam after completing the core courses.

**MATH 599. Research & Thesis. (3-6 Credits)**