MAT - MATHEMATICS

For details on Mathematics prerequisite requirements, please see the* Mathematics Placement Information *(https://bulletins.wayne.edu/undergraduate/college-liberal-arts-sciences/mathematics/placement/) section of this bulletin, or the* Mathematics Placement Exam *(http://testing.wayne.edu/register/math-placement-exam.php) information provided by the Office of Testing, Evaluation and Research Services.

MAT 1000 Mathematics in Today's World Cr. 3
Satisfies General Education Requirement: Quantitative Experience Comp
An exploration of current applications of mathematics, such as gerrymandering, consumer mathematics, cryptography, identification numbers, art, music, statistical design, optimal decision making, and risk assessment. Offered Every Term.
Restriction(s): Enrollment is limited to Undergraduate level students.

MAT 1010 Beginning Algebra Cr. 3,5
Satisfies General Education Requirement: Quantitative Experience Comp
Review of arithmetic, integers, fractions, decimals, percents, ratios. Algebra: solving equations and inequalities, algebraic expressions, graphing, problem solving. Offered Every Term.

MAT 1070 College Algebra Cr. 5
Satisfies General Education Requirement: Quantitative Experience Comp
A college algebra course with emphasis on functions. Topics include: properties of the real number system, equations and inequalities, lines, graphs, algebra of functions, modeling, exponents, logarithms, systems of equations and conic sections, and introduction to trigonometry if time allows. Warning: This course may not be equivalent to college algebra courses at other institutions. Therefore, this course in conjunction with a trigonometry course taken elsewhere is not sufficient preparation for MAT 2010 (Calculus I). Prerequisites are subject to specific conditions. Refer to the Mathematics Placement Information page referenced at the top of the Mathematics course listings in the University Bulletin. Some sections are offered by the Rising Scholars Program (RSP). These sections require departmental approval and must be taken with MAT 1075, a two-hour workshop. Email emergingscholars@wayne.edu for more information regarding the RSP sections. Offered Every Term.
Prerequisites: MAT 1010 with a minimum grade of C- (must be taken at WSU), MAT Permit to Reg ACT/SAT with a test score minimum of 2-4, or Math Permit to Reg - (L1-L4) with a test score minimum of 2-4

MAT 1075 Problem Solving for College Algebra Cr. 2
Students work collaboratively on challenging problems related to "College Algebra." Communication skills are taught through group discussions and journal writing. Serving students in the Rising Scholars Program, students are immersed in an environment that promotes a sense of community and the habits of success. This course must be taken with a Rising Scholars Program (RSP) MAT 1070 section. Email emergingscholars@wayne.edu for more information. Offered Fall, Winter.
Corequisite: MAT 1070

MAT 1110 Mathematics for Elementary School Teachers I Cr. 3
Satisfies General Education Requirement: Quantitative Experience Comp
Problem solving, sets, functions, reasoning, number theory, whole numbers, integers, fractions, decimals. Prerequisites are subject to specific conditions. Refer to the Mathematics Placement Information page referenced at the top of the Mathematics course listings in the University Bulletin. Offered Fall, Winter.
Prerequisites: MAT 1070-6999 with a minimum grade of C- (must be taken at WSU), Math Permit to Reg - (L1-L4) with a test score minimum of 3-4, or MAT Permit to Reg ACT/SAT with a test score minimum of 3-4

MAT 1120 Mathematics for Elementary School Teachers II Cr. 3
Satisfies General Education Requirement: Quantitative Experience Comp
Statistics, probability, geometry, and measurement. Prerequisites are subject to specific conditions. Refer to the Mathematics Placement Information page referenced at the top of the Mathematics course listings in the University Bulletin. Offered Fall, Winter.
Prerequisites: MAT 1110 with a minimum grade of C- (must be taken at WSU), MAT Permit to Reg ACT/SAT with a test score minimum of 3-4, or Math Permit to Reg - (L1-L4) with a test score minimum of 3-4

MAT 1400 Artificial Intelligence and the Conscious Mind Cr. 3
Satisfies General Education Requirement: Cultural Inquiry
This course provides an introduction to philosophical and scientific thinking about Artificial Intelligence (AI). The public release of Large Language Models (LLMs) such as ChatGPT and relatives has created both high hopes for the future and also deep worries. Generative AI systems such as LLMs now display nearly human-level abilities at tasks that would require genuine intelligence and consciousness if performed by humans. But what are AIs really doing in performing these tasks? Are AIs intelligent, understanding, conscious? Could they be in the near future? Our overall aim in this course is to gain some understanding of the workings of neural networks, machine learning, and AI, to combine that with an understanding of philosophical and cognitive scientific approaches to understanding mentality and consciousness, and thereby to take a few baby steps toward putting together answers to these important questions. Offered Yearly.
Equivalent: PHI 1400

MAT 1800 Elementary Functions Cr. 4
Satisfies General Education Requirement: Quantitative Experience Comp
Basic definition and concept of function. Definitions, properties and graphs of polynomial, rational, exponential, logarithmic, trigonometric, and inverse trigonometric functions. Only two degree credits after MAT 1500. Students in the Emerging Scholars Program must also enroll in the accompanying problem-solving workshop: MAT 1990, for a total of six credits. Prerequisites are subject to specific conditions. Refer to the Mathematics Placement Information page referenced at the top of the Mathematics course listings in the University Bulletin. Offered Every Term.
Prerequisites: MAT 1070 with a minimum grade of C- (must be taken at WSU), MAT Permit to Reg ACT/SAT with a test score minimum of 3-4, or Math Permit to Reg - (L1-L4) with a test score minimum of 3-4

MAT 1990 Precalculus Workshop Cr. 2
Students work cooperatively in groups to solve challenging problems related to precalculus. Learning is through discovery rather than by lecture. Offered Every Term.

MAT 2010 Calculus I Cr. 4
Satisfies General Education Requirement: Quantitative Experience Comp
Calculus as the study of change. Definitions, concepts, and interpretations of the derivative and the definite and indefinite integrals; differentiation, integration, applications. No credit after former MAT 1510. Students in the Emerging Scholars Program must also enroll in the accompanying problem-solving workshop: MAT 2110, for a total of six credits. Prerequisites are subject to specific conditions. Refer to the Mathematics Placement Information page referenced at the top of the Mathematics course listings in the University Bulletin. Offered Every Term.
Prerequisites: MAT 1800 with a minimum grade of C-, MAT Permit to Reg ACT/SAT with a test score minimum of 4, or Math Permit to Reg - (L1-L4) with a test score minimum of 4

MAT 2020 Calculus II Cr. 4
Satisfies General Education Requirement: Quantitative Experience Comp Review definition of definite integral and fundamental theorem of calculus. Techniques of integration; approximate integration; improper integrals; applications of integration. Sequences and series. Approximating functions by polynomials and Taylor series. Students in the Emerging Scholars Program must also enroll in the accompanying problem-solving workshop: MAT 2120, for a total of six credits. Prerequisites are subject to specific conditions. Refer to the Mathematics Placement Information page referenced at the top of the Mathematics course listings in the University Bulletin. Offered Every Term.
Prerequisites: MAT 2010 with a minimum grade of C-

MAT 2030 Calculus III Cr. 4
Multivariable calculus with applications. Vectors and vector functions in two and three dimensions; functions of several variables; differentiation; integration; vector calculus. Offered Every Term.
Prerequisites: MAT 2020 with a minimum grade of C-

MAT 2110 Calculus Workshop I Cr. 2
Students work cooperatively in groups to solve challenging problems related to calculus. Learning is through discovery rather than by lecture. Offered Every Term.
Prerequisites: MAT 2010 with a minimum grade of C- (may be taken concurrently)

MAT 2120 Calculus Workshop II Cr. 2
Students work cooperatively in groups to solve challenging problems related to calculus. Learning is through discovery rather than by lecture. Offered Winter.
Prerequisites: MAT 2020 with a minimum grade of C-

MAT 2150 Differential Equations and Matrix Algebra Cr. 4
Differential equations and applications; basic operations of matrices from linear algebra. Only one degree credit after MAT 2350. Offered Every Term.
Prerequisites: MAT 2030 with a minimum grade of C-

MAT 2250 Elementary Linear Algebra Cr. 3
Topics include: systems of linear equations, matrices, vector spaces, basis, dimension, inner products, linear transformations and eigenvalues. Applications presented. Offered Every Term.
Prerequisites: MAT 2020 with a minimum grade of C-

MAT 2300 Mathematical Epidemiology Cr. 3
This is a first course in the mathematical modeling of infectious diseases. The course starts with historical, biological, and mathematical background. We introduce basic epidemic models (SIR, SIS, SIRS) first without and then with demographics, and study the properties of these models. We will learn about more complex epidemic models (SEIR, etc.) and how to validate models using real-world data. If time permits, other topics may include: vector-borne disease models, global stability, or control strategies. Offered Yearly.
Prerequisites: MAT 2020 with a minimum grade of C-

MAT 2350 Elementary Differential Equations Cr. 3
Topics include: first order equations, higher order linear equations, Laplace transforms, linear systems. Applications presented throughout the course. No degree credit after MAT 2150. Offered Yearly.
Prerequisites: MAT 2030 with a minimum grade of C- and MAT 2250 with a minimum grade of C-

MAT 2500 Fundamentals of Mathematics and Proof-Writing Cr. 3
This course is a writing-intensive introduction to mathematical proofs, where students will learn to read and write mathematics in definition-theorem-proof format. The mathematical content of the course is elementary set theory (finite and infinite sets, cardinality, Zorn's Lemma and the Axiom of Choice, the Continuum Hypothesis) and elementary analysis (metric spaces and the real numbers). Offered Yearly.
Prerequisites: MAT 2010 with a minimum grade of C-

MAT 2860 Discrete Mathematics Cr. 3
Foundations of mathematics: logic and mathematical reasoning; sets, functions, sequences; the integers and the Euclidean algorithm; induction, recursive definitions and recurrence relations; graphs. Combinatorics. Graph theory. Boolean algebra. No credit after former MAT 1860 or 1870. Offered Yearly.
Prerequisites: MAT 2010 with a minimum grade of C-

MAT 3430 Applied Differential and Integral Calculus Cr. 4
Limits, derivatives, applications of derivatives, definite integrals and their applications, and trigonometric functions. No degree credit in College of Liberal Arts and Sciences. Offered Every Term.
Prerequisites: MAT 1800 with a minimum grade of C-
Equivalent: ET 3430

MAT 3450 Applied Calculus and Differential Equations Cr. 4
Continuation of MAT/ET 3430, including logarithmic and exponential functions, first and second order ordinary differential equations, vectors, polar coordinates, Laplace transforms, Taylor series, and Fourier series. No degree credit in College of Liberal Arts and Sciences. Offered Every Term.
Prerequisites: ET 3430 with a minimum grade of C- or MAT 2010 with a minimum grade of C-
Equivalent: ET 3450

MAT 3800 Contemporary Topics in Mathematics Cr. 3
The content of this course will vary from semester to semester. It will cover topics of current interest that are not part of other mathematics courses. Offered Intermittently.
Prerequisites: MAT 2020 with a minimum grade of C-
Repeatable for 12 Credits

MAT 4990 Directed Study: Honors Program Cr. 1-4
Offered Intermittently.
Repeatable for 8 Credits

MAT 5040 Elementary Abstract Algebra Cr. 4
This is an introduction to some of the main ideas of number theory and abstract algebra. The course also serves to introduce students to the uses and benefits of abstraction, and to the construction of airtight logical arguments. We start with a careful investigation of familiar number systems: the natural numbers, the integers, the rationals, the reals and the complex numbers. We then proceed to generalize these ideas to consider polynomial rings and fields. Offered Fall.
Prerequisites: MAT 2010 with a minimum grade of C- and 1 of (MAT 2500 with a minimum grade of C- or MAT 2860)

MAT 5070 Elementary Analysis Cr. 4
Topics include: the real numbers, cardinality, sequences, limits, continuity, uniform continuity, differentiation, integration. Offered Fall, Winter.
Prerequisites: MAT 2030 with a minimum grade of C- and (MAT 2150 with a minimum grade of C-, MAT 2250 with a minimum grade of C-, or MAT 2350 with a minimum grade of C-)

MAT 5100 Numerical Methods I Cr. 3
Numerical errors; solutions of nonlinear equations; polynomial interpolation; numerical approximation; numerical integration and differentiation; numerical solutions of systems of linear equations; numerical solutions of ordinary differential equations. Offered Fall.
Prerequisites: MAT 2030 with a minimum grade of C-, MAT 2250 with a minimum grade of C-, and (BE 1500 with a minimum grade of C- or (CSC 1100 with a minimum grade of C- and CSC 1101 with a minimum grade of C-))

MAT 5120 Abstract Algebra for Middle School Teachers Cr. 3
Topics from elementary abstract algebra underpinning middle school mathematics curriculum; historical connections; role of abstraction and proof in mathematics. No credit towards major in mathematics or secondary mathematics. Offered Every Other Year.
Prerequisites: MAT 1120 with a minimum grade of C- and MAT 1800 with a minimum grade of C-
Equivalent: MAE 5120

MAT 5180 Geometry for Middle School Teachers Cr. 3
Development of Euclidean geometry as a mathematical system; related historical topics; introduction to other geometries; selected topics such as transformations and tessellations. No credit toward a major or minor for secondary mathematics teaching. Offered Every Other Year.
Prerequisites: MAT 1110 with a minimum grade of C- and MAT 1120 with a minimum grade of C-
Equivalent: MAE 5100

MAT 5190 Number Theory for Middle School Teachers Cr. 3
Topics from elementary theory of numbers which underlie middle school mathematics; historical connections; role of abstraction and proof in mathematics. No credit toward a major or minor for secondary mathematics teaching. Offered Every Other Year.
Prerequisites: MAT 1800 with a minimum grade of C- or MAT 1120 with a minimum grade of C-
Equivalent: MAE 5110

MAT 5210 Advanced Calculus Cr. 4
Functions of many variables; limits, continuity; differentiation, mean value theorems; implicit and inverse function theorems; extremal problems, Lagrange multipliers; fixed-point methods; Taylor series; Fourier series, uniform convergence; improper integrals. Offered Every Other Winter.
Prerequisites: MAT 2150 with a minimum grade of C-, MAT 2350 with a minimum grade of C-, or (MAT 2030 with a minimum grade of C- and MAT 2250 with a minimum grade of C-)

MAT 5220 Partial Differential Equations Cr. 4
Partial differential equations of mathematical physics; review of second-order Linear ODEs with constant coefficients; method of separation of variables; Fourier series; Sturm-Liouville eigenvalue problems; boundary-value problems; method of eigenfunction expansion. Optional topics include Green's functions, solutions by Fourier transform, and method of characteristics. Offered Every Other Fall.
Prerequisites: MAT 2150 with a minimum grade of C-, MAT 2350 with a minimum grade of C-, or (MAT 2030 with a minimum grade of C- and MAT 2250 with a minimum grade of C-)

MAT 5230 Complex Variables and Applications Cr. 4
Cauchy-Riemann equations; elementary functions; mappings by elementary functions; the Cauchy integral formula; Morera's theorem; Taylor series; Laurent series; residues and poles; conformal mappings. Optional topics: improper integrals, the Schwarz-Christoffel transformations; potential theory; applications to differential and integral equations. No credit after MAT 6600. Offered Every Other Winter.
Prerequisites: MAT 2150 with a minimum grade of C-, MAT 2350 with a minimum grade of C-, or (MAT 2030 with a minimum grade of C- and MAT 2250 with a minimum grade of C-)

MAT 5280 Methods of Differential Equations Cr. 3
Linear nth order differential equations; linear systems of differential equations (constant and periodic coefficients); oscillation and comparison theorems for second order differential equations; boundary value problems; stability theory (Liapunov's direct method and frequency domain stability criteria); asymptotic solutions; autonomous non-linear systems; classification of singularities. Offered Fall.
Prerequisites: MAT 2150 with a minimum grade of C- or MAT 2350 with a minimum grade of C-

MAT 5350 Logical Systems I Cr. 4
Metaresults concerning formal systems of sentential and first-order logics; soundness, completeness; independence of axioms; introduction to recursive functions; formalization of elementary arithmetic; discussion of Godel's incompleteness theorem and Church's Theorem. Offered Every Other Year.
Prerequisites: MAT 5600 with a minimum grade of C-, PHI 2850 with a minimum grade of C-, PHI 2860 with a minimum grade of C-, PHI 5050 with a minimum grade of C-, or MAT 5420 with a minimum grade of C-
Equivalent: PHI 5350

MAT 5400 Elementary Theory of Numbers Cr. 3
Primes and the Fundamental Theorem of Arithmetic; greatest common divisor, least common multiple, Euclidean Algorithm; congruences, theorems of Fermat, Wilson and Euler; arithmetic functions; linear Diophantine equations; quadratic congruences and the Law of Quadratic Reciprocity. Optional topics include: applications to cryptography, perfect numbers, primitive roots and indices, Fibonacci numbers, Pythagorean triples, sums of squares, continued fractions. Offered Yearly.
Prerequisites: MAT 2030 with a minimum grade of C- and MAT 2250 with a minimum grade of C-

MAT 5410 Applied Linear Algebra Cr. 4
Gaussian elimination, vector spaces, the four fundamental subspaces, orthogonality, least squares approximation, determinants, eigenvalues and eigenvectors, positive definite matrices, singular value decomposition, linear transformations, complex matrices. Applications such as differential and difference equations, Markov processes, graphs and networks, Fourier series, computer graphics, numerical linear algebra. Offered Winter.
Prerequisites: MAT 2030 with a minimum grade of C- and MAT 2250 with a minimum grade of C-

MAT 5420 Algebra I Cr. 4
Abstract concepts: sets, mappings, equivalence relations, induction, general methods of proof. Group theory: groups, subgroups, cyclic groups, direct products, cosets, Lagrange's Theorem, quotient groups, homomorphisms, permutation groups. Rings and fields (basic definitions). Offered Fall, Winter.
Prerequisites: MAT 2030 with a minimum grade of C- and MAT 2250 with a minimum grade of C-

MAT 5430 Algebra II Cr. 4
Group theory continued: Sylow Theorems, finite abelian groups. Ring theory: rings, integral domains, fields of quotients, homomorphisms, ideals, quotient rings, P.I.D.s, U.F.D.s, polynomial rings. Advanced topics in linear algebra: canonical forms. Field theory: extensions, splitting fields, finite fields, geometric constructions. Offered Fall, Winter.
Prerequisites: MAT 5420 with a minimum grade of C-

MAT 5530 Elementary Differential Geometry and its Applications Cr. 3
Introduction to the differential geometry of curves and surfaces in three-dimensional space. Curvature, torsion, Frenet formulas, fundamental theorem of space curves. Gauss and mean curvature, asymptotic and principal curves, geodesics, Gauss-Bonnet theorem. Applications such as pursuit curves, roulettes, brachistochrones, precession of Foucault's pendulum, design of packaging machines, shapes and soap films. Offered Intermittently.
Prerequisites: MAT 2030 with a minimum grade of C- and MAT 2250 with a minimum grade of C-

MAT 5540 Topological Data Analysis Cr. 3
Application of topological methods to reveal structure in data that are not visible by classical statistical methods. Basic ideas in topology, including topological spaces, continuous functions, homeomorphisms, simplicial complexes, simplicial homology, and the Vietoris-Rips complex. Use of computer software to calculate persistent homology of data sets from the applied sciences and elsewhere. Practical data analysis tools for mathematical sciences, as well as for engineering, physics, biology, medicine, economics, sociology, and any other subject in which experimental data is produced and analyzed. Offered Winter.
Prerequisites: MAT 2250 with a minimum grade of C-

MAT 5600 Introduction to Analysis I Cr. 4
Completeness, convergence, compactness, connectedness and continuity in the context of metric spaces; applications to differential calculus. Offered Fall, Winter.
Prerequisites: MAT 5070 with a minimum grade of C-

MAT 5610 Introduction to Analysis II Cr. 3
Integration, point-wise and uniform convergence of sequences and series of functions; power series; introduction to analytic functions; Fourier series; possible additional topics. Offered Fall, Winter.
Prerequisites: MAT 5600 with a minimum grade of C-

MAT 5700 Introduction to Probability Theory Cr. 4
Probability spaces; combinatorial analysis; independence and conditional probability; discrete and continuous random variables including binomial, Poisson, exponential and normal distributions; expectations; joint, marginal and conditional distribution functions; law of large numbers; central limit theorems. Offered Fall, Winter.
Prerequisites: MAT 2030 with a minimum grade of C-

MAT 5710 Introduction to Stochastic Processes Cr. 3
Non-measure-theoretic introduction to the theory of stochastic processes and its applications, with emphasis on Markov processes in both discrete and continuous time, the Poisson process, and Brownian motion. Offered Yearly.
Prerequisites: 2 of MAT 5700 with a minimum grade of C- and (MAT 2150 with a minimum grade of C-, MAT 2250 with a minimum grade of C-, or MAT 2350 with a minimum grade of C-)

MAT 5740 The Theory of Interest Cr. 3
Concrete problems used to explore concepts in the theory of interest, including measurement of interest, annuities, yield rates, amortization, bonds, and stochastic approaches. Students prepare for the actuarial examination FM/2. Offered Yearly.
Prerequisites: MAT 2020 with a minimum grade of C-

MAT 5750 Mathematics of Finance Cr. 3
Topics to be covered include: financial markets, binomial models, stocks and options, Black-Scholes formula, hedging, bond models and interest rate options, and computational methods for bonds. Offered Winter.
Prerequisites: (1 of (MAT 2150 or MAT 2350) and MAT 5700 with a minimum grade of C-)

MAT 5770 Mathematical Models in Operations Research Cr. 3
Deterministic and probabilistic mathematical modeling of real-world problems. Linear and nonlinear programming; Markov chains; queuing theory; inventory models; Markov decision processes. Offered Yearly.
Prerequisites: MAT 2030 with a minimum grade of C-, MAT 2250 with a minimum grade of C-, and MAT 5700 with a minimum grade of C-

MAT 5870 Methods of Optimization Cr. 3
Introduction to basic mathematical theory and computational methods of optimization; unconstrained and constrained optimization problems; optimality conditions in various optimization problems; numerical methods of optimization. Offered Winter.
Prerequisites: MAT 2150 with a minimum grade of C- or MAT 2350 with a minimum grade of C-

MAT 5890 Special Topics in Mathematics Cr. 3-4
Material currently of interest to students and faculty. Topics to be announced in Schedule of Classes. Offered Fall, Winter.
Prerequisites: MAT 2030 with a minimum grade of C- and (MAT 2150 with a minimum grade of C-, MAT 2250 with a minimum grade of C-, or MAT 2350 with a minimum grade of C-)
Repeatable for 12 Credits

MAT 5990 Directed Study Cr. 1-4
Undergraduates who elect this course must be mathematics majors of honors caliber. Content will vary to satisfy needs of individual student. Offered Every Term.
Repeatable for 8 Credits

MAT 5992 Teaching Mathematics in College Cr. 1
Preparation for first semester of teaching in developmental-level mathematics course. Content presentation, test-writing, grading, classroom management, use of technology. Students are videotaped and critiqued. Required of all graduate teaching assistants in Mathematics Department. Offered for S and U grades only. Offered Fall.
Restriction(s): Enrollment limited to students with a class of Senior; enrollment is limited to students with a major in Mathematics or Mathematics Honors; enrollment is limited to Graduate or Undergraduate level students.

MAT 6130 Discrete Mathematics Cr. 3
Foundations of mathematics: logic, sets, functions, sequences. The integers. Matrices. Mathematical reasoning: induction, recursive definitions and recurrence relations. Combinatorics. Graph theory. Boolean algebra. No credit after former MAT 1860 or 1870. Not available to Math majors for degree credit. Offered Yearly.
Prerequisites: MAT 2010 with a minimum grade of C-
Restriction(s): Enrollment limited to students in the College of Education.

MAT 6140 Geometry: An Axiomatic Approach Cr. 3
Foundations: logic, axiom systems, models; Hilbert's axioms; the parallel postulate; Euclidean geometry; non-Euclidean geometries; hyperbolic geometry; philosophical questions. Offered Yearly.
Prerequisites: MAT 2500 with a minimum grade of C- or MAT 2860 with a minimum grade of C-

MAT 6150 Probability and Statistics for Teachers Cr. 4
Counting techniques, discrete sample spaces and probability, random variables, mean and variance, joint distributions, the binomial and normal distributions, central limit theorem, estimation and hypothesis testing. Not available to Math majors for degree credit. Offered Fall, Winter.
Prerequisites: MAT 1800 with a minimum grade of C
Restriction(s): Enrollment limited to students in the College of Education.

MAT 6300 Mathematical Epidemiology Cr. 3
This is a first course in the mathematical modeling of infectious diseases. The course starts with historical, biological, and mathematical background. We introduce basic epidemic models (SIR, SIS, SIRS) first without and then with demographics, and study the properties of these models. We will learn about more complex epidemic models (SEIR etc.), and how to validate models using real-world data. If time permits, other topics may include: vector-borne disease models, global stability, or control strategies. No credit will be awarded to students who have previously taken MAT 2300. Graduate students in mathematics should take advanced courses in differential equations instead. Offered Yearly.
Prerequisites: MAT 2020 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 6420 Advanced Linear Algebra Cr. 3
Vector spaces and linear maps from a basis free perspective. Vector spaces, linear transformations, dual spaces, quotient spaces, inner product spaces, quadratic forms, adjoint operators, normal operators, spectral theorem, Jordan canonical form, trace and determinant. Offered Winter.
Prerequisites: MAT 5430 with a minimum grade of C-

MAT 6480 Introduction to Quantum Computing Cr. 3
Serves as an introduction to quantum computing and brings together students with different backgrounds in mathematics, physics, chemistry, and computer science to foster interdisciplinary connections in the areas of quantum computing and quantum information. A strong background in linear algebra over the complex numbers as well as differential and integral calculus is required. Familiarity with quantum physics and complexity theory will be helpful, but it is not required. Offered Fall.
Equivalent: PHY 6480

MAT 6500 Topology I Cr. 3
Topological spaces and continuous functions; connectedness; compactness; product and quotient spaces; metric spaces; Urysohn's lemma; Tietze extension theorem; homotopy; covering spaces and path lifting; the fundamental group and examples; Brouwer fixed point theorem and applications. Offered Fall.
Prerequisites: MAT 5430 with a minimum grade of C- or MAT 5610 with a minimum grade of C-

MAT 6600 Complex Analysis Cr. 2-4
Complex differentiation; elementary functions; Cauchy's integral theorem; power series; Laurent expansions; singularities; residue theorem; entire and meromorphic functions; Riemann mapping theorem. Offered for three credits only, if student has taken MAT 5230. Offered Winter.
Prerequisites: MAT 5430 with a minimum grade of C- or MAT 5610 with a minimum grade of C-

MAT 6990 Internship in Mathematical Sciences Cr. 1-3
Experience in industry, or in a research laboratory, or in an institution, using tools from the mathematics curriculum. Students provide a written report based on the internship experience. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students; enrollment is limited to students in the Department of Mathematics.
Repeatable for 3 Credits

MAT 7200 Ordinary Differential Equations Cr. 3
Existence and uniqueness of solutions; linear solutions and linearization; linear differential equations in the complex domain; solutions near regular and irregular singular points; autonomous systems; stability theory; limit cycles; perturbation theory; boundary value problems; Green's function; spectral theory. Offered Winter.
Prerequisites: MAT 5610 with a minimum grade of C or MAT 7600 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7210 Partial Differential Equations Cr. 3
Linear partial differential equations; fundamental solutions; distributions and their Fourier transforms; hyperbolic equations; Cauchy-Kovalevsky theorem; energy inequalities; weak solutions; propagation of singularities; elliptic equations; maximum principles; Sobolev spaces and inequalities; Garding's inequality; existence and regularity of solutions of Dirichlet problems; fundamental solutions of parabolic equations; strongly continuous semigroups. Offered Fall.
Prerequisites: MAT 5610 with a minimum grade of C or MAT 7600 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7230 Finite Element Methods Cr. 3
Topics chosen at discretion of instructor from topics similar to: regularity theory for second order elliptic partial differential equations; Hamilton-Jacobi equations; conservation laws; evolution equations; semigroup theory; calculation of variations; nonvariational methods. Offered Winter.
Prerequisite: MAT 5100 with a minimum grade of C- and MAT 5070 with a minimum grade of C-
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7240 Advanced Partial Differential Equations Cr. 3
Continuation of MAT 7210. Variety of topics chosen by the instructor. Offered Winter.
Prerequisite: MAT 7210 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7270 Topics in Applied Mathematics Cr. 3-4
Topics of special interest such as differential equations; calculus of variations; elliptic functions; orthogonal functions; numerical methods; systems and control theory. Topics to be announced in Schedule of Classes . Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

MAT 7400 Advanced Algebra I Cr. 3
Groups; group actions; group automorphisms; Sylow theorems; direct and semi-direct products; abelian groups; nilpotent and solvable groups; free groups; vector spaces and canonical forms; field extensions; Galois theory; finite fields; cyclotomic extensions; abelian extensions; Galois groups of polynomials. Offered Every Other Fall.
Prerequisite: MAT 5430 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7410 Advanced Algebra II Cr. 3
Rings; ideals; maximal and prime ideals; modules; submodules and quotient modules; tensor products; flatness; exactness of Hom and tensor; localization; rings of fractions; integrality; Noetherian and Artinian rings; completions; representation theory; group rings; injective and projective modules; Wedderburn theorem; character theory. Offered Every Other Fall.
Prerequisite: MAT 5430 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7470 Topics in Algebra Cr. 3-4
Selected topics from algebra. Offered Yearly.
Prerequisite: MAT 7400 with a minimum grade of C or MAT 7410 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

MAT 7500 Topology II Cr. 3
Smooth manifolds and maps; examples from projective spaces, from Lie groups, and from low dimensions; local coordinates; partitions of unity; tangent vectors and tangent bundles; differentials of smooth maps; vector fields; local one-parameter groups of diffeomorphisms; differential forms; integration and Stokes theorem; definition of deRham cohomology. Offered Winter.
Prerequisite: MAT 6500 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7510 Algebraic Topology I Cr. 3
CW complexes; simplicial, singular, and cellular homology; Mayer-Vietoris sequences; categories and functors; derived functors of Ext and tensor; universal coefficients theorem; Künneth theorem; cohomology; cup product; orientations; Poincaré duality. Offered Every Other Winter.
Prerequisite: MAT 5430 with a minimum grade of C and MAT 6500 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7520 Algebraic Topology II Cr. 3
Fundamental group; Van Kampen's theorem; covering spaces; homotopy groups; Whitehead's theorem; cellular and CW approximation; excision; Hurewicz theorem; cofibrations and fibrations; cofiber and fiber sequences; Postnikov towers; obstruction theory. Offered Every Other Winter.
Prerequisite: MAT 5430 with a minimum grade of C and MAT 6500 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7570 Topics in Geometry and Topology Cr. 3-4
Selected topics from geometry and topology. Offered Yearly.
Prerequisite: MAT 7500 with a minimum grade of B or MAT 7510 with a minimum grade of B or MAT 7520 with a minimum grade of B
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

MAT 7600 Real Analysis I Cr. 3
Lebesgue measure; general measures; measurable functions; integration (monotone and dominated convergence theorems); function spaces; Lebesgue spaces; modes of convergence; product measures; Fubini theorem. Offered Fall.
Prerequisite: MAT 5610 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7610 Real Analysis II Cr. 3
Differentiation; relationship between differentiation and integration; Radon-Nikodym theorem; Fourier transforms; Hilbert and Banach spaces; selected topics. Offered Winter.
Prerequisite: MAT 7600 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7700 Advanced Probability Theory I Cr. 3
Probability spaces; random variables; expectations and moments; convergence concepts; product spaces and Kolmogorov extension theorem; separability of random processes; continuity of random processes; conditional expectation; independence. Offered Every Other Fall.
Prerequisite: MAT 5700 with a minimum grade of C and MAT 7600 with a minimum grade of C
Restriction(s): Enrollment is limited to Graduate level students.

MAT 7990 Directed Study Cr. 1-4
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

MAT 7999 Master's Essay Direction Cr. 1-3
Offered Every Term.
Restriction(s): Enrollment limited to students with a class of Candidate Masters; enrollment is limited to Graduate level students.
Repeatable for 3 Credits

MAT 8000 Advanced Topics in Mathematics Cr. 2-4
Topics to be announced in Schedule of Classes. Offered Yearly.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 24 Credits

MAT 8999 Master's Thesis Research and Direction Cr. 1-8
Offered Every Term.
Restriction(s): Enrollment limited to students with a class of Candidate Masters; enrollment is limited to Graduate level students.
Repeatable for 8 Credits

MAT 9990 Pre-Doctoral Candidacy Research Cr. 1-8
Research in preparation for doctoral dissertation. Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 12 Credits

MAT 9991 Doctoral Candidate Status I: Dissertation Research and Direction Cr. 3-9
Offered Every Term.
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 9 Credits

MAT 9992 Doctoral Candidate Status II: Dissertation Research and Direction Cr. 1-18
Offered Every Term.
Prerequisite: MAT 9991 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 18 Credits

MAT 9993 Doctoral Candidate Status III: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Prerequisite: MAT 9992 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.

MAT 9994 Doctoral Candidate Status IV: Dissertation Research and Direction Cr. 7.5
Offered Every Term.
Prerequisite: MAT 9993 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.

MAT 9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction Cr. 0
Offered Every Term.
Prerequisite: MAT 9994 with a minimum grade of S
Restriction(s): Enrollment is limited to Graduate level students.
Repeatable for 0 Credits