MATH - Mathematics

Courses numbered 500 to 799 = *undergraduate/graduate*. (Individual courses may be limited to undergraduate students only.) Courses numbered 800 to 999 = *graduate*.

MATH 501. Elementary Mathematics (5).
A study of topics necessary to an understanding of the elementary school curriculum, such as set theory, real numbers and geometry. Not for major or minor credit. Prerequisite(s): elementary education major and MATH 111 or equivalent with a grade point of 2.000 or better, or departmental consent.

MATH 502. Mathematics for Middle School Teachers (5).
A study of the mathematical knowledge which forms the theoretical foundations of, the applications of, and extensions of middle school mathematics. This capstone course serves to reinforce mathematics skills learned in prerequisite courses and assists students in recognizing the unifying principles within their mathematical experiences. Prerequisite(s): MATH 111, 121, 123, 144, 501, and STAT 370 or equivalent with a grade point of 2.000 or better in each.

MATH 511. Linear Algebra (3).
An elementary study of linear algebra, including an examination of linear transformations and matrices over finite dimensional spaces. Prerequisite(s): MATH 243 with a grade point of 2.000 or better.

MATH 530. Applied Combinatorics (3).
Basic counting principles, occupancy problems, generating functions, recurrence relations, principles of inclusion and exclusion, the pigeonhole principle, Fibonacci sequences and elements of graph theory. Prerequisite(s): MATH 344 with a grade point of 2.000 or better.

MATH 531. Introduction to the History of Mathematics (3).
General education math course. Studies the development of mathematics from antiquity to modern times. Solves problems using the methods of the historical period in which they arose. Requires mathematical skills. Prerequisite(s): MATH 511 and two additional courses at the 500 level or above, with a grade point of 2.000 or better in each.

MATH 547. Advanced Calculus I (3).
Covers the calculus of Euclidean space including the standard results concerning functions, sequences and limits. Prerequisite(s): MATH 344 and 415 with a grade point of 2.000 or better in each.

MATH 548. Introduction to Complex Variables (3).
Study of complex numbers, analytic functions, differentiation and integration of complex functions, line integrals, power series, residues and poles, and conformal mapping with applications. Prerequisite(s): MATH 344 with a grade point of 2.000 or better.

MATH 551. Numerical Methods (3).
Approximating roots of equations, interpolation and approximation, numerical differentiation and integration, and the numerical solution of first order ordinary differential equations. Some computer use. Prerequisite(s): MATH 344 and 451 with a grade point of 2.000 or better, or departmental consent.

MATH 553. Mathematical Models (3).
Covers case studies from the fields of engineering technology and the natural and social sciences. Emphasizes the mathematics involved. Each student completes a term project which is the solution of a particular problem approved by the instructor. Prerequisite(s): Math 344 with a grade point of 2.000 or better, or departmental consent.

MATH 555. Differential Equations I (3).
A study of first order equations including separation of variables and exact equations, second order equations including the general theory of initial value problems, constant coefficients, undetermined coefficients, variation of parameters and special methods of solution using power series and the Laplace transform methods. A standard course in differential equation for students in the sciences and engineering. Prerequisite(s): MATH 243 with a grade point of 2.000 or better, or departmental consent.

MATH 555H. Differential Equations I Honors (3).
A study of first order equations including separation of variables and exact equations, second order equations including the general theory of initial value problems, constant coefficients, undetermined coefficients, variation of parameters and special methods of solution using power series and the Laplace transform methods. A standard course in differential equation for students in the sciences and engineering. Prerequisite(s): MATH 243 with a grade point of 2.000 or better, or departmental consent.

MATH 580. Selected Topics In Math (1-3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 580A, 580B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): departmental consent.

MATH 580AA. Introduction to Partial Differential Equations (3).
Introduction to the basic properties of partial differential equations and to the techniques that have proved useful in analyzing them. The purpose of this course is to provide for the student a broad perspective on the subject, to illustrate the rich variety of phenomena encompassed by it, and to impart a working knowledge of the most important techniques of analysis of the solutions of the equations. Prerequisite(s): MATH 344.

MATH 580B. Introduction to Elementary Differential Geometry: A First Course in Curves and Surfaces (3).
Introduction to the theory of curves and surfaces. Prerequisite(s): MATH 344, MATH 415 and MATH 511; MATH 525 is recommended, but not required. Pre- or corequisite(s): MATH 547.

MATH 613. Fundamental Concepts of Algebra (3).
Defines group, ring and field, and studies their properties. Prerequisite(s): MATH 415 and MATH 511 with a grade point of 2.000 or better, or departmental consent.

MATH 615. Elementary Number Theory (3).
Studies properties of the integers by elementary means. Prerequisite(s): MATH 344 with a grade point of 2.000 or better, or departmental consent.

MATH 620. Introduction to Elementary Differential Geometry: A First Course in Curves and Surfaces (3).
Introduction to the theory of curves and surfaces. Prerequisite(s): MATH 511, (MATH 525 recommended). Pre- or corequisite(s): MATH 547.

MATH 621. Elementary Geometry (3).
Studies Euclidean geometry from an advanced point of view. Prerequisite(s): MATH 344 with a grade point of 2.000 or better, or departmental consent.

MATH 625. Elementary Topology (3).
Studies topological spaces, open and closed sets, bases for topology, continuous mappings, homeomorphisms, connectedness and compactness, Hausdorff and other spaces, with special emphasis on metric spaces. Prerequisite(s): MATH 415 with a grade point of 2.000 or better.

MATH 640. Advanced Calculus II (3).
A further study of the calculus of Euclidean space including integration theory and multidimensional differentiation. Prerequisite(s): MATH 511 and MATH 547 with a grade point of 2.000 or better in each.

MATH 646. Introduction to Mathematical Data Analysis (3).
Introduces basic mathematical tools and principles for data analysis techniques used in analyzing data sets. Topics include matrix decomposition, gradient descent, continuous optimization, linear regression, dimension reduction and clustering. For students to be successful in this course, basic calculus and statistics knowledge is needed prior to enrolling. Prerequisite(s): departmental consent.

MATH 655. Differential Equations II (3).
A continuation of MATH 555 (but with more emphasis on theoretical issues) that covers higher order differential equations, systems of first order equations (including the basics of linear algebra), some numerical methods, and stability and behavior of solutions for large times. Prerequisite(s): MATH 555 with a grade point of 2.000 or better, or departmental consent.

MATH 657. Optimization Theory (3).
Introduces selected topics in linear and nonlinear optimization. Develops the revised simplex method along with a careful treatment of duality. Then extends the theory to solve parametric, integer and mixed integer linear programs. Prerequisite(s): MATH 511 with a grade point of 2.000 or better.

MATH 713. Abstract Algebra I (3).
Treats the standard basic topics of abstract algebra. Prerequisite(s): MATH 613 with a grade point of 2.000 or better, or departmental consent.

MATH 720. Modern Geometry (3).
Introduction to smooth manifolds with heavy emphasis on surfaces as a primary example. Prerequisite(s): MATH 620 with a grade point of 2.500 or better, or departmental consent.

MATH 725. Topology I (3).
Studies the results of point set and algebraic topology. Prerequisite(s): MATH 547 with a grade point of 2.000 or better, or departmental consent.

MATH 743. Real Analysis I (3).
Includes a study of the foundations of analysis and the fundamental results of the subject. Prerequisite(s): MATH 640 with a grade point of 2.000 or better, or departmental consent.

MATH 745. Complex Analysis I (3).
Studies the theory of analytic functions. Prerequisite(s): MATH 640 with a grade point of 2.000 or better, or departmental consent.

MATH 746. Introduction to Data Analytics (3).
Covers basic mathematical techniques for analyzing data sets. Uses object oriented programming, like Python or R, to show how to organize, visualize and analyze large data. For students to be successful in this course, basic programming knowledge is needed prior to enrolling. Prerequisite(s): MATH 511, 571, or instructor's consent.

MATH 750Y. Smooth Manifolds (3).
Knowledge of differentiable manifolds has become very important in a large number of areas of mathematics and of its applications. In fact, much of advanced calculus and analysis is based on the study of differentiable manifolds. For example, topics such as line and surface integrals, divergence and curl of vector fields and Stokes' and Green's theorems are most naturally described using manifold theory. Course gives a careful introduction to differentiable manifolds, illustrating each new definition and theorem with the study of spheres, tori, real and complex projective spaces, and matrix groups. Talks about tangent spaces, vector fields, differential forms and integral curves. Concludes with Stokes' theorem on manifolds.

MATH 750Z. Data Analytics' (3).
Covers basic mathematical techniques for analyzing data sets. The course will use Python to show how to organize, visualize, and analyze large data. Prerequisite(s): MATH 511, STAT 571, basic programming knowledge.

MATH 751. Numerical Linear Algebra (3).
Includes analysis of direct and iterative methods for the solution of linear systems, linear least squares problems, Eigenvalue problems, error analysis, and reduction by orthogonal transformations. Prerequisite(s): MATH 511, 547, 551 with a grade point of 2.000 or better in each, or departmental consent.

MATH 753. Ordinary Differential Equations (3).
Covers existence, uniqueness, stability and other qualitative theories of ordinary differential equations. Prerequisite(s): MATH 547 with a grade point of 2.000 or better, or departmental consent.

MATH 755. Partial Differential Equations I (3).
Studies the existence and uniqueness theory for boundary value problems of partial differential equations of all types. Prerequisite(s): MATH 547 with a grade point of 2.000 or better, or departmental consent.

MATH 757. Partial Differential Equations for Engineers (3).
Includes Fourier series, the Fourier integral, boundary value problems for the partial differential equations of mathematical physics, Bessel and Legendre functions, and linear systems of ordinary differential equations. Prerequisite(s): MATH 555 with a grade point of 2.000 or better.

MATH 758. Complex and Vector Analysis for Engineers (3).
A survey of some of the mathematical techniques needed in engineering including an introduction to vector analysis, line and surface integrals, and complex analysis, contour integrals and the method of residues. Not applicable toward a graduate degree in mathematics. Prerequisite(s): MATH 555 with a grade point of 2.000 or better.

MATH 781. Cooperative Education (1-3).
Academic program that expands a student's learning experiences through paid employment in a supervised educational work setting related to the student's major field of study or career focus. Repeatable for credit. May not be used to satisfy degree requirements. Prerequisite(s): departmental consent, graduate GPA of 3.000 or above.

MATH 802. Data Analytics Capstone (3).
Individual directed study in an area of data analytics appropriate for each student's career objectives. Project must be approved and guided by a member of the graduate faculty. If an internship is used in substitution for this course, it needs to be approved prior to the start date of the internship, and the project(s) must be reported to a graduate faculty member. Prerequisite(s): successful completion of at least 12 credit hours of courses approved for the certificate program with a GPA of 3.000 or better, declaration of intent for certificate prior to enrolling.

MATH 813. Abstract Algebra II (3).
A further study of the standard basic topics of abstract algebra. Prerequisite(s): MATH 713 or equivalent.

MATH 820. Riemannian Geometry (3).
Riemannian geometry is the study of smooth manifolds equipped with a smooth metric. In this course, students cover the basics of Riemannian geometry including, but not limited to, Riemannian metrics, affine and Riemannian connections, geodesics, convex neighborhoods, the three most basic forms of curvature (sectional, Ricci and scalar), and Jacobi fields. Prerequisite(s): MATH 720 and MATH 743.

MATH 825. Topology II (3).
A further study of algebraic topology. Prerequisite(s): MATH 725 or equivalent.

MATH 828. Selected Topics Topology (2-3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 828A, 828B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): departmental consent.

MATH 828M. Characteristic Classes (3).
Provides an introduction to the theory of characteristic classes. Topics include vector bundles, principal G-bundles, classifying spaces, the cohomology of classifying spaces, connections on principal bundles, and Chern-Weil theory. Prerequisite(s): MATH 725.

MATH 829. Selected Topics in Geometry (2-3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 829A, 829B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): departmental consent.

MATH 829AA. Introduction to Compact Lie Groups (3).
Introduces the student to the theory of compact Lie groups with a focus on those compact Lie groups that are matrix groups. Knowledge of proof writing and basic linear algebra are assumed.

MATH 829V. Geometric Analysis (3).
An introduction to geometric analysis. Students study and solve partial differential equations (PDEs) on smooth manifolds, arising from conformal geometry. Many of the problems are variational problems and the solutions to the PDEs are highly related to the underlying geometry. The topics range from tensor analysis and curvature computations, elliptic PDE theories and estimates, Sobolev spaces, Green's function, uniformization theorem, to Yamabe problem. Prerequisite(s): MATH 820 or departmental consent.

MATH 829Z. Convex Geometry (3).
Discusses convex geometry. Topics include the Brunn-Minkowski inequality, John's ellipsoid theorem, isotropic position, polar bodies and polytopes. If there is interest, topics in discrete geometry such as Minkowski's theorems are discussed. Topics discussed change based on student interest.

MATH 843. Real Analysis II (3).
A further study of the foundations of analysis and the fundamental results of the subject. Prerequisite(s): MATH 743 or equivalent.

MATH 845. Complex Analysis II (3).
A further study of the theory of analytic functions. Prerequisite(s): MATH 745 or equivalent.

MATH 848. Calculus of Variations (3).
Includes Euler-Lagrange equations, variational methods and applications to extremal problems in continuum mechanics. Prerequisite(s): MATH 547 or 757.

MATH 849. Selected Topics in Analysis (2-3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 849A, 849B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): departmental consent.

MATH 849I. Introduction to Harmonic Analysis on Euclidean Spaces (3).
Introduces the Fourier transform on Rn and the theory of partial sums of Fourier series of functions on [0, 1]. Specific topics include Calder ´on-Zygmund decomposition, the Hardy-Littlewood Maximal operator, and the Riesz-Thorin and Marcinkiewicz interpolation theorems. Prerequisite(s): MATH 843 with a grade of 2.000 or better.

MATH 849J. Analytic Number Theory (3).
Introduces a number of topics in number theory. Discusses the theory of Dirichlet series such as the Riemann zeta function. The relationship between Dirichlet series and arithmetic functions is explored via the Mellin transform. Specifically, the zero-free region for the Riemann zeta function is used to show the prime number theorem and the value of L(1, #) for Dirichlet characters # are used to establish Dirichlet's theorem on arithmetic progressions. Prerequisite(s): MATH 745 or departmental consent.

MATH 849K. Boundary Value Problems for Analytic Functions (3).
Provides an introduction to the theory of boundary value problems for analytic functions which is an important branch of complex analysis. Topics covered include integrals of the Cauchy Type, Hilbert and Riemann-Hilbert Boundary Value Problems, the modified Dirichlet problem, Green's function, and harmonic measure. Some applications to problems in physics and engineering are discussed. Prerequisite(s): MATH 548 or MATH 745 or departmental consent.

MATH 852. Numerical Analysis of Partial Differential Equations (3).
Includes analysis of algorithms for the solution of initial value problems and boundary value problems for systems of PDEs with applications to fluid flow, structural mechanics, electromagnetic theory and control theory. Prerequisite(s): MATH 751.

MATH 856. Partial Differential Equations II (3).
A further study of the existence and uniqueness theory for boundary value problems of partial differential equations of all types. Prerequisite(s): MATH 755.

MATH 857. Selected Topics in Engineering Mathematics (3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 857A, 857B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Not applicable toward the MS in mathematics.

MATH 858. Selected Topics in Engineering Mathematics II (3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 858A, 858B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Not applicable toward the MS in mathematics.

MATH 859. Selected Topics in Applied Mathematics (2-3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 859A, 859B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course.

MATH 859O. Inverse Problems in Partial Differential Equations (3).
A study of basic results in inverse problems for elliptic and parabolic partial differential equations. Goal is to understand and use some existing methods of proving uniqueness, stability and possibly existence (the orthogonality relations, exponential and singular solutions, etc.).

MATH 859P. Numerical Conformal Mapping (3).
Provides an introduction to the numerical computation of conformal mappings for simply and multiply connected domains using the boundary integral equation with the generalized Neumann kernel. Some

applications to problems in physics and engineering are discussed. Prerequisite(s): departmental consent.

MATH 881. Individual Reading (1-5).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 881A, 881B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): departmental consent.

MATH 881AA. Polynomial Reconstruction and Neural Networks (1).
Gegenbauer reconstruction is an important approach in spectral methods to recover high order of accuracy. In this individual reading class, the student studies the Gegenbauer reconstruction for discontinuous function with neural network.

MATH 881AB. Applications of Conformal Mapping (3).
Applications of conformal mapping: We will consider applications of conformal mapping to inverse problems.

MATH 881AD. Low-Sensitivity Design of Complex Systems (5).
Studies possible sources of uncertainty (nonlinearity, sampling period, time delay), systems with random noise (stochastic systems), model reduction techniques of continuous-time systems (singular perturbation), model reduction techniques of discrete-time systems (two-time-scale systems), and dynamic feedback controller (observer-based controller).

MATH 885. Thesis (1-4).
Student-driven research experience to address a specific research question. Potential topics should be formulated by the student and discussed with their advisor. Repeatable for credit. Prerequisite(s): departmental consent.

MATH 941. Applied Functional Analysis I (3).
Introduces functional analysis and its applications. Prerequisite(s): MATH 843. Pre- or corequisite(s): MATH 755.

MATH 942. Applied Functional Analysis II (3).
A further study of topics in functional analysis and its applications. Prerequisite(s): MATH 941.

MATH 947. Theory Fluid Dynamics I (3).
Mechanics of fluid flow, momentum and energy principles, Navier-Stokes and Euler equations, potential flows, vortex dynamics, stability analysis and numerical methods applied to fluid dynamics. Prerequisite(s): MATH 745.

MATH 948. Theory Fluid Dynamics II (3).
Mechanics of fluid flow, momentum and energy principles, Navier-Stokes and Euler equations, potential flows, vortex dynamics, stability analysis and numerical methods applied to fluid dynamics. Prerequisite(s): MATH 745.

MATH 952. Advanced Topics in Numerical Analysis (3).
Advanced topics of current research interest in numerical analysis. Topics chosen at instructor's discretion. Possible areas of concentration are numerical methods in ordinary differential equations, partial differential equations and linear algebra. Repeatable with departmental consent. Prerequisite(s): MATH 751, 851, and instructor's consent.

MATH 958. Selected Advanced Topics in Applied Mathematics (3).
An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 958A, 958B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): instructor's consent.

MATH 958I. Inverse Problem (3).
A study of various inverse problems in partial differential equations. Prerequisite(s): MATH 856 or departmental consent.

MATH 981. Advanced Independent Study in Applied Mathematics (1-3).
Arranged individual directed study in an area of applied mathematics. Repeatable to a maximum of 6 hours. Prerequisite(s): must have passed the PhD qualifying exam and instructor's consent.

MATH 985. PhD Dissertation (1-9).
Student-driven research experience to address a specific research question. Potential topics should be formulated by the student and discussed with their advisor. Repeatable for credit. Prerequisite(s): must have passed the PhD preliminary exam.