MATHEMATICS (MATH)

MATH 5000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

MATH 5001 Special Topics (LEC 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

MATH 5010 Graduate Seminar (SEM 1.0)
Discussion of advanced or current topics.

MATH 5040 Oral Examination (IND 0.0)
After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/ comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

MATH 5099 Graduate Research (IND 0.0-6.0)
Investigation of an advanced nature leading to the preparation of a MS thesis or dissertation.

MATH 5105 Modern Algebra I (LEC 3.0)
Equivalence relations and functions, basic properties of groups, subgroups, permutations, cosets and Lagrange's Theorem, homomorphisms and isomorphisms, factor groups. Prerequisite: Math 3109 or graduate standing; preceded or accompanied by Math 3108.

MATH 5106 Modern Algebra II (LEC 3.0)
This course is a continuation of Math 5105. Rings and fields are discussed. Euclidean domains, principal ideal domains, unique factorization domains, vector spaces, finite fields and field extensions are studied. Prerequisite: Math 5105.

MATH 5107 Combinatorics And Graph Theory (LEC 3.0)
Covers some basics of enumeration and graph theory. Topics are selected from the following: permutations combinations, the inclusion/ exclusion principle, generating functions, recurrence relations, trees, networks, graph connectivity and graph coloring. Prerequisite: Comp Sci 1200 or Math 3109.

MATH 5108 Linear Algebra II (LEC 3.0)
Eigenvalue problems, Cayley-Hamilton theorem, Jordan normal form, linear functionals, bilinear forms, quadratic forms, orthogonal and unitary transformations, selected applications of linear algebra. Prerequisite: Math 3108.

MATH 5154 Mathematical Logic I (LEC 3.0)
A mathematical introduction to logic with some applications. Functional and relational languages, satisfaction, soundness and completeness theorems, compactness theorems. Examples from Mathematics, Philosophy, Computer Science, and/or Computer Engineering. Prerequisite: Philos 3254 or Math 5105 or Comp Sci 2500 or Comp Eng 2210. (Co-listed with Comp Eng 5803, Comp Sci 5203 and Philos 4354).

MATH 5215 Introduction To Real Analysis (LEC 3.0)
Riemann-Stieltjes integration, sequences and series of functions, uniform approximation, the Banach Space C(a,b), Lebesgue measure and integration, the space LP(a,b), Fourier series. Prerequisite: Math 4209.

MATH 5222 Vector And Tensor Analysis (LEC 3.0)
Vector algebra, vector differential and integral calculus, line and surface integrals, theorems of Stokes and Gauss, tensor algebra and tensor analysis, applications to problems in kinematics, elasticity theory, fluid mechanics, electromagnetic theory, relativity theory. Prerequisite: Math 2222; Math 3103 or Math 3108.

MATH 5302 Intermediate Differential Equations (LEC 3.0)
Linear differential equations, vector-matrix systems, existence and uniqueness theory, nonlinear systems, phase-plane analysis, introduction to stability theory. Prerequisite: A grade of "C" or better in Math 2222 and Math 3304.

MATH 5325 Partial Differential Equations (LEC 3.0)
Linear equations, heat equation, eigenfunction expansions, Green's formula, inhomogeneous problems, Fourier series, wave equation. Prerequisite: A grade of "C" or better in Math 2222 and Math 3304.

MATH 5351 Introduction To Complex Variables (LEC 3.0)
The basic tools of complex variables are studied. These include the Cauchy-Riemann equations, complex contour integration, the Cauchy-Goursat theorem, conformal mappings, the calculus of residues and applications to boundary value problems. Prerequisite: A grade of "C" or better in Math 2222 and Math 3304.

MATH 5483 Operational Calculus (LEC 3.0)
The Laplace transformation, properties of the transformation, various applications to ordinary and partial differential equations, systems with step and Dirac functions as driving forces, various non-elementary functions and their transforms, problems in heat conduction and wave motion, Fourier transforms and their operational properties. Prerequisite: A grade of "C" or better in Math 2222 and Math 3304.

MATH 5512 Introduction To Differential Geometry (LEC 3.0)
Elements of the geometry of curves and surfaces in Euclidean three-space using methods of advanced calculus and vectors. Prerequisite: Math 4209 or Math 5222.

MATH 5530 Topics in Geometry - Graduate Option (LEC 3.0)
A survey of non-Euclidean geometries, finite geometries, affine and projective planes, metric postulates for the Euclidean plane, and selected topics. Students will demonstrate graduate-level mastery of the subject matter. Credit will not be given for both Math 4530 and Math 5530. Prerequisites: MATH 3108.

MATH 5585 Introduction To Topology (LEC 3.0)
Metric spaces; general topological spaces; connectedness, compactness, separation properties, functions and continuity. Prerequisite: Math 4209.

MATH 5601 Introduction to Numerical Analysis (LEC 3.0)
Mathematical foundation and theory of the basic numerical methods for nonlinear equations, function approximations, numerical differentiation/integration, ordinary differential equations, and matrix computation, including convergence, accuracy, and stability analysis; extension of the basic methods to the corresponding more advanced methods. Prerequisites: A grade of "C" or better in Math 3108 or Math 3304, and Comp Sci 1570, Comp Sci 1970, Comp Sci 1971, or Comp Sci 1972.

MATH 5602 Mathematical Foundation of Finite Element Methods (LEC 3.0)
Implementation and theoretical analysis of the finite element method for the approximate solution of partial differential equations. Implementation of finite element methods for elliptic and parabolic equations. Theoretical analysis of convergence, accuracy, and stability of approximate solutions. Prerequisites: Math 5601, or any instructor approved 4000-level or higher course from another discipline with a significant computational component.

MATH 5603 Methods of Applied Mathematics (LEC 3.0)
Methods to develop and analyze mathematical models. Topics include dimensional analysis and scaling, perturbation methods, and the construction of ordinary and partial differential equation models. Prerequisites: A grade of "C" or better in Math 2222 and Math 3304; programming competency.

MATH 5604 Introduction to Numerical Methods for Differential Equations (LEC 3.0)
An introduction to finite difference methods for ordinary and partial differential equations, including (1) the derivation of the numerical methods, (2) implementation of the methods in Matlab, and (3) the mathematical accuracy and stability analysis of the methods. Prerequisites: A grade of "C" or better in Math 2222 and Math 3304; programming competency (preferably Matlab).

MATH 5680 Mathematics of Machine Learning (LEC 3.0)
Mathematics, programming, data analysis, and graphics associated with machine learning. Probability, Naïve Bayes classifier, stochastic gradient descent, self-organizing maps, decision trees and other tree-based methods, perception, reinforcement learning, keras, and neural networks. These topics will be treated from a mathematical viewpoint. Prerequisites: A grade of "C" or better in Math 2222; programming competency.

MATH 5737 Financial Mathematics (LEC 3.0)
The course objective is to provide an understanding of the fundamental concepts of financial mathematics. Topics include pricing, assets-liability management, capital budgeting, valuing cash flow, bonds, futures, swaps, options. Preparation for the financial mathematics actuarial exam will be provided. Prerequisites: Math 1215 or Math 1221, Econ 1100 or Econ 1200, and one of the following: Stat 3111, Stat 3113, Stat 3115, Stat 3117 or Stat 5643. (Co-listed with Econ 5337).

MATH 5762 Marketing Revolution with Machine Learning (LEC 3.0)
This course introduces machine learning and artificial intelligence applications in marketing innovation contexts through case studies and industry collaborations, explores the underlying mathematics and implements algorithms using Python programming language. Prerequisites: Graduate standing or one of the following: Math 1212 or Math 1214. (Co-listed with MKT 5762).

MATH 6000 Special Problems (IND 0.0-6.0)
Problems or readings on specific subjects or projects in the department. Consent of instructor required.

MATH 6001 Special Topics (LEC 0.0-6.0)
This course is designed to give the department an opportunity to test a new course. Variable title.

MATH 6010 Graduate Seminar (RSD 1.0-3.0)
Discussion of topics of current interest. Prerequisite: Graduate standing.

MATH 6040 Oral Examination (IND 0.0)
After completion of all other program requirements, oral examinations for on-campus M.S./Ph.D. students may be processed during intersession. Off-campus M.S. students must be enrolled in oral examination and must have paid an oral examination fee at the time of the defense/ comprehensive examination (oral/ written). All other students must enroll for credit commensurate with uses made of facilities and/or faculties. In no case shall this be for less than three (3) semester hours for resident students.

MATH 6050 Continuous Registration (IND 1.0)
Doctoral candidates who have completed all requirements for the degree except the dissertation, and are away from the campus must continue to enroll for at least one hour of credit each registration period until the degree is completed. Failure to do so may invalidate the candidacy. Billing will be automatic as will registration upon payment.

MATH 6099 Research (IND 0.0-15)
Investigation of an advanced nature leading to the preparation of a thesis or dissertation.

MATH 6105 Finite Fields And Applications (LEC 3.0)
After reviewing basic group theory and introducing basic properties of commutative rings, the main focus of the course will be on topics such as structure of finite fields, polynomials over finite fields, and applications such as coding theory and cryptography. Prerequisite: Math 5105.

MATH 6106 Introduction to Ring Theory (LEC 3.0)
Properties of rings with an emphasis on commutative rings. Ideals, factor rings, ring homomorphisms, polynomial rings; factorization, divisibility, and irreducibility. Introduction to extension fields and Galois theory. Applications may be chosen based on the interests of the students. Prerequisite: Math 5105.

MATH 6107 Group Theory (LEC 3.0)
Groups, subgroups, and factor groups; homomorphisms, isomorphisms, and associated theorems; abelian groups; Sylow theorems and p-groups; permutation groups; free groups and generators; representation theory; cohomology theory. Prerequisite: Math 5106.

MATH 6108 Applied Matrix Theory (LEC 3.0)
A second course in matrix theory directed toward applications. Linear spaces, linear operators, equivalence and similarity, spectral theorem, canonical forms, congruence, inertia theorem, quadratic forms, singular value decomposition and other factorizations, generalized inverses. Applications to optimization, differential equations, stability. Prerequisites: Math 3103, 3108, or 5302.

MATH 6215 Functions Of A Real Variable I (LEC 3.0)
Measure spaces, extensions of measures, probability spaces, measures and distributions in normed linear spaces, product measures, independence, integral and expectation, convergence theorems, Radon-Nikodyn theorem and applications. Lp spaces, selected topics. Prerequisite: Math 5215.

MATH 6216 Functions Of A Real Variable II (LEC 3.0)
Abstract measures and integrals, the Daniell integration theory, integration on locally compact Hausdorff spaces, integration in function spaces, selected topics. Prerequisite: Must be preceded by Math 6215.

MATH 6330 Theory Of Differential Equations I (LEC 3.0)
Stability theory, Liapunov's direct method, periodic solutions, Poincare-Bendixson theory, applications. Prerequisite: Math 5302.

MATH 6331 Theory Of Differential Equations II (LEC 3.0)
Continuation of Math 6330. Nonlinear oscillations, solutions near singular points, asymptotic methods, differential equations on manifolds, boundary-value problems. Prerequisite: Math 5302.

MATH 6375 Theory Of Partial Differential Equations (LEC 3.0)
Sobolev spaces; existence, uniqueness, and regularity of weak solutions to linear elliptic, parabolic, and hyperbolic PDEs; selected topics. Prerequisite: Math 6417.

MATH 6417 Functional Analysis I (LEC 3.0)
Banach spaces, Hilbert spaces, linear transformations, Hahn-Banach theorem, duality, uniform boundedness principle, weak topologies, convexity, bounded linear maps, compact operators, and spectral theory. Prerequisites: Math 5215; Math 5108 or Math 5585.

MATH 6418 Functional Analysis II (LEC 3.0)
A continuation of Math 6417 with additional topics related to bounded and unbounded operators and their applications. Prerequisites: Math 6215 and Math 6417.

MATH 6461 Harmonic Analysis I (LEC 3.0)
Fourier series, norm and pointwise convergence of Fourier series, the conjugate and maximal functions, analytic functions in the unit disk and Hardy spaces, interpolation of linear operators and the Hausdorff-Young-Riesz Theorem, Sidon sets. Prerequisites: Math 5215 and Math 5351.

MATH 6462 Harmonic Analysis II (LEC 3.0)
Fourier integrals, almost-periodic functions on the real line, Banach algebras, Wiener's Tauberian Theorem and the prime number theorem, the Paley-Wiener Theorems, band-limited functions and Shannon's Theorem, the continuous wavelet transform, discrete wavelet transforms and frames, orthonormal bases of wavelets and multi-resolution analysis. Prerequisite: Must be preceded by Math 6461.

MATH 6490 Nonlinear Optimization in Machine Learning (LEC 3.0)
Nonlinear optimization methods and background information in machine learning, including convex functions, steepest descent, line search method, heavy-ball method, accelerated gradient method, stochastic gradient descent and variance reduced gradient, coordinate descent, alternating directions, and nonconvex optimization. Prerequisites: Math 2222 and Math 3108 and Stat 3115 or Stat 3117 or Stat 5643.

MATH 6585 Topology I (LEC 3.0)
Topological spaces, uniform and quasi-uniform spaces, product and quotient spaces, separation properties and connected spaces, compactness. Prerequisite: Math 5585.

MATH 6586 Topology II (LEC 3.0)
Metrizability conditions, the theory of convergence using both filters and nets, completions and compactifications, and papers from the recent literature. Prerequisite: Math 6585.

MATH 6601 Numerical Analysis (LEC 3.0)
A proof based course emphasizing theoretical analysis of convergence and accuracy of various numerical methods including approximate solutions of linear and nonlinear equations, numerical integration, and function approximation, with implementation to validate results and illustrate the methods. Prerequisites: Any 4000 or higher level MATH course, or any instructor approved 4000 or higher level course from another discipline with a significant computational component.

MATH 6603 Mathematical Foundations of Finite Element Methods II (LEC 3.0)
Finite element methods for systems of partial differential equations and nonlinear partial differential equations. Mathematical theory for mixed finite elements, non-conforming finite elements, finite element interpolation, and finite element projections. Prerequisites: Math 5325 or Math 6601 or Math 6602.

MATH 6665 Mathematical Programming (LEC 3.0)
Linear optimization and its engineering applications; problem modeling, search-based optimization, the simplex method for solving linear problems, multi-objective optimization, discrete dynamic programming. Applications of optimization in the fields such as transportation, project management, manufacturing and facility location will be discussed. Prerequisites: One of the following:Stat 3113, Stat 3115, or Stat 3117; Math 3108. (Co-listed with Eng Mgt 6412 and Sys Eng 6412).

MATH 6737 Financial Mathematics II (LEC 3.0)
Continuation of Math 5737/Econ 5337. Topics include martingales and measures, stopping times, discrete and continuous time finance, Brownian motion, Ito calculus, stochastic differential equations, Black-Scholes-Merton formula, numerical procedures. Prerequisite: Math 5737 or Econ 5337. (Co-listed with Econ 6337).

MATH 6802 Mathematical Physics I (LEC 3.0)
Vector spaces, generalized coordinate transformations, vector analysis, tensors, partial differential equations in physics and boundary value problems, orthogonal functions and solutions to ordinary differential equations, hypergeometric, confluent hypergeometric, Legendre, Laguerre, and Bessel functions, Hermite polynomials, Green's functions in one dimension. (Co-listed with Physics 6403).