GRADUATE MATHEMATICS COURSES

MAT 5300 Introduction to Analysis. Real and complex number systems, elements of topology on the real line, rigorous treatment of limits, continuity, differentiation, and Riemann integration, introduction to metric spaces, pointwise and uniform convergence for sequences and series of functions, introduction to differential forms, introduction to Lebesgue integration.
Prerequisite: graduate standing or permission of department.

MAT 5301 Functions of a Real Variable. Fundamentals of real analysis and applications; development of real number system; set-theoretic notions; Lebesgue measure and and integral; introduction to Hilbert space; real orthogonal expansion; L^p spaces; applications to the Fourier series and Fourier and more general transforms.
Prerequisite: graduate standing or permission of department.

MAT 5405 Functions of a Complex Variable. Integration and differentiation in the complex domain – Cauchy's theorem, Cauchy integral formula, Laurent expansion, residues; elements of conformal mapping, special functions, series and product representations.
Prerequisite: graduate standing or permission of department.

MAT 5310 Topology. Point set topology: metric spaces and topological spaces, compactness, connectedness, continuity, extension theorems, separation axioms, quotient spaces, topologies on function spaces, Tychonoff theorem.
Prerequisite: graduate standing or permission of department.

MAT 5330 Algebra. Sets, Boolean algebra, cardinal numbers, groups, rings and ideals, integral domains, fields, algebraic number fields, Galois theory.
Prerequisite: graduate standing or permission of department.

MAT 5250 Differential Geometry. Classic differential geometry of curves and surfaces in space; intrinsic geometry of a surface: tensor calculus and differential forms with applications to Riemannian geometry in n dimensions; differential and Riemannian geometry in the large.
Prerequisite: graduate standing or permission of department.

MAT 5302 Ordinary Differential Equations. Differential equations in the real domain; existence and stability theory, Sturm-Liouville problem for linear equations, techniques of solution for special classes; differential equations in the complex domain, equations of Fuchsian type and special functions; transform methods; Hamiltonian systems.
Prerequisite: graduate standing or permission of department.

MAT 5340 Partial Differential Equations. Introduction to the theory of partial differential equations of second order; problem of Cauchy, boundary value problems of potential theory, variational principles.
Prerequisite: graduate standing or permission of department.

MAT 5110 Mathematical Statistics. Events and probabilities, random variables, means and variances, conditioning and independence, the central limit theorem, normal distribution and other important distributions, confidence intervals for one-parametric models, maximum

likelihood estimation, conditional probability density functions.
Prerequisite: graduate standing or permission of department.

MAT 5510 Functional Analysis. Banach and Hilbert spaces, linear functionals, Hahn-Banach theorem, dual spaces, linear operators, closed graph theorem, Riesz theory for compact operators, spectral theory, function and Banach algebras**.** *Prerequisite: graduate standing or permission of department.*

MAT 5401 Dynamical Systems. Qualitative theory of differential equations, bifurcation theory, and Hamiltonian systems; differential dynamics, including hyperbolic theory and quasiperiodic dynamics; low-dimensional dynamics; introduction to ergodic theory. *Prerequisite: graduate standing or permission of department.*

MAT 5100 Mathematical Modeling. Ordinary and partial differential equations of physical and biological problems; simplification, dimensional analysis, scaling, regular and singular perturbation theory, variational formulation of physical problems, continuum mechanics, fluid flows.
Prerequisite: graduate standing or permission of department.

MAT 5640 Mathematics of Finance. Fundamental topics will be covered: risk, arbitrage, mathematical models for asset price movements (based on trees, PDEs, and martingales); pricing of financial derivatives, and hedging; introduction to stochastic calculus, and to the Black-Scholes model.
Prerequisite: graduate standing or permission of department.

MAT 5511 Stochastic Calculus. Stochastic processes, including Brownian processes and Poisson processes, stochastic integration and differentiation, solving stochastic differential equations, martingale calculus, martingale measures, Black-Scholes model of a financial market.
Prerequisite: graduate standing or permission of department.

MAT 5400 Scientific Computing. Numerical computation for mathematical sciences: error analysis, floating-point arithmetic, nonlinear equations, numerical solution of systems of algebraic equations, banded matrices, least squares, unconstrained optimization, polynomial interpolation, numerical differentiation and integration, numerical solution of ordinary differential equations, truncation error, numerical stability for time dependent problems and stiffness.
Prerequisite: graduate standing or permission of department.

MAT 5500 Methods of Mathematical Physics. Selected topics in mathematical physics, such as mathematical methods of classical mechanics, electrodynamics, relativity, quantum mechanics and quantum field theory.
Prerequisite: graduate standing or permission of department.

MAT 5410 Topics in Analysis. Possible topics may include: abstract functional analysis, Hilbert and Banach spaces, general operator theory: integral equations and transforms, Fredholm and Hilbert-Schmidt theory, special equations.
Prerequisite: graduate standing or permission of department.

MAT 5420 Topics in Complex Variables. Possible topics may include: geometrical function theory, Riemann surface theory, extremal problems, conformal mapping, automorphic functions, and Nevanlinna theory.
Prerequisite: graduate standing or permission of department.

MAT 5311 Topics in Differential Equations. Possible topics may include: general theory of linear partial differential equations, Cauchy and boundary value problems, estimates, regularity of the solutions: nonlinear partial differential equations.
Prerequisite: graduate standing or permission of department.

MAT 5390 Topics in Topology. Possible topics may include: homotopy theory, fundamental group and covering spaces, singular homology and cohomology theory, axions of homology theory, Mayer/Vietoris sequence, calculation of homology and cohomology of standard spaces, cell complexes and cellular homology, de Rham theorem on isomorphism of de Rham differential-form cohomology and singular cohomology with real coefficients. Differentiable manifolds and smooth maps, tangent bundles, immersions, embeddings, submanifolds, transversality, Sard's Theorem, intersection theory. Computational topology.
Prerequisite: graduate standing or permission of department.

MAT 5490 Topics in Dynamical Systems. Possible topics may include: elements of ergodic theory, invariant measures and sets, ergodicity, ergodic theorems, mixing, spectral theory. Applications of dynamical systems to number theory, celestial mechanics, chaos, and fractals.
Prerequisite: graduate standing or permission of department.

MAT 5251 Topics in Differential Geometry. Possible topics may include: Lie groups and Lie algebras; vector bundles and connections. Morse theory. Elements of Hodge theory. Tensor calculus with applications to geometry in *n* dimensions. Elements of geometric analysis (harmonic maps). Applications to special and general relativity, high-energy physics and gauge-field theory.
Prerequisite: graduate standing or permission of department.

MAT 5491 Topics in Complex Systems. Possible topics may include: nonlinear and fractal time series; computational methods; network science; applications include econophysics, fractal statistics, and neural physics.
Prerequisite: graduate standing or permission of department.

MAT 5200 Topics in Foundations of Mathematics. Possible topics may include: formal logic, naive set theory, Russell's paradox, sets and classes, transfinite ordinals and cardinals, the real number system, well-ordering and Zorn's lemma, other systems of set theory, relative consistency proofs, consistency of the axiom of choice and the generalized continuum hypothesis, Boolean logics, truth functions, quantification theory, Godel's completeness theorem, Turing machines, recursive functions, unsolvable decision problems, word problems, Post normal systems, Hilbert's tenth problem, incompleteness theorems, computable functionals, degrees of recursive unsolvability.
Prerequisite: graduate standing or permission of department.

MAT 5600 Topics in Mathematics of Finance. Possible topics may include: portfolio theory, risk management, game theory, applications to financial economics and econometrics.
Prerequisite: graduate standing or permission of department.

MAT 5402 Topics in Scientific Computing. This is an advanced graduate course on scientific computing. The aim of the course is to present some advanced techniques of scientific computing with applications to many areas of science. For example: integration of ODEs and PDEs for physics and engineering; singular value decomposition for dimension reduction and compression; Monte Carlo methods for statistics, probability, and finance; optimization for operations research.
Prerequisite: graduate standing or permission of department.

MAT 5930. Topics in Mathematical Physics (3 credits).

MAT 5931 Graduate Student Seminar (0-1 credits). Students attend seminar lectures to get exposure and knowledge in various areas of modern mathematics.
Prerequisite: graduate standing or permission of department.

MAT 5940 Internship/Practical Training (3-6 credits). The internship/practical training provides graduate students with opportunities to gain practical, career-related experience in a variety of supervised field settings. This involves participation in a project that requires applications of mathematics, numerical methods, or statistics, which is conducted outside the university in a governmental, commercial, or academic setting. Open only to graduate students with permission of the Director of Graduate Studies. Students must submit a brief written description of their work to the DGS before starting the internship and submit a written summary of their work when it is completed.

MAT 5900 Readings in Mathematics (3-6 credits). Topics to be arranged, depending on the interests and backgrounds of the students. Given only by arrangement with the instructor.
Prerequisite: graduate standing or permission of department.

MAT 8970 Thesis Research (1-9 credits). Preparation of MA or PhD Thesis under the supervision of adviser; credits will vary for masters and doctoral students.
Prerequisite: graduate standing or perm