School	Arts and Sciences		
Major	Master of Science in Applied Mathematics		
Core courses			
Code	**Title**	**Credits**	**Description**
MATH502	Algebra	**3**	Graduate algebra builds on two undergraduate courses in abstract algebra and a sound knowledge of linear algebra. Topics include the classification of finitely generated abelian groups, Sylow's theorems and their applications, simple groups, field extensions, algebraic and transcendental elements, splitting fields, finite fields, the Fundamental Theorem of Galois Theory, and the solution of polynomial equations by radicals. The final part treats modules: submodules, quotient and product modules, module homomorphisms, the isomorphism theorems, direct sums, free modules, and finitely generated modules over a principal ideal domain.
MATH505	Numerical Linear Algebra	**3**	The course is divided into two parts. The first part introduces general numerical techniques based on finite difference method to solve elliptical and parabolic partial differential equations. The second part of the course introduces the finite volume method. Students will be given the chance to implement the introduced numerical techniques and solve some practical problems in heat transfer and fluid flow using finite volume method or finite difference method on MATLAB.
MATH510	Real Analysis	**3**	This course provides a rigorous foundation in modern real analysis, focusing on measure theory, Lebesgue integration, and Lp-spaces. Key topics include Carathéodory's construction, major convergence theorems, Lp-duality, weak convergence, convolution operators, and the Fourier transform on Rn. Students develop essential analytical techniques for advanced study in functional analysis, partial differential equations, probability, and harmonic analysis.
MATH520	Functional Analysis	**3**	This course gives an advanced introduction to functional analysis and operator theory, with applications to differential and integral equations. It covers metric, normed, Banach, and Hilbert spaces, along with bounded linear operators, dual spaces, adjoint and compact operators, and spectral concepts. Fundamental theorems (Hahn–Banach, Uniform Boundedness, Open Mapping, Closed Graph, Riesz Representation, and Banach Fixed Point) are proved and applied to operator equations, integral equations, and boundary-value problems.
MATH522	Topology	**3**	Topology studies the properties of spaces that are preserved under continuous deformation, independently of distance and coordinates. Topics include topological spaces, bases, subspaces, closed sets, continuity and homeomorphisms, product, metric and quotient topologies, connectedness and compactness, countability and separation axioms, the Tychonoff theorem, and homotopy and the fundamental group of circles, spheres and selected surfaces. Emphasis is on rigorous proof, problem solving, and the use of examples and counterexamples. The material provides foundations for modern analysis, geometry and further research.
MATH560	Modern Differential Geometry	**3**	Differential geometry uses calculus to study spaces that are locally Euclidean but may have a complicated global structure, such as the sphere, where shortest paths are arcs of great circles rather than straight lines. Topics include smooth manifolds and smooth structures, charts and atlases, smooth maps, tangent and cotangent bundles, vector fields and Lie brackets, immersions, submersions and embeddings, differential forms and pullbacks, and integration on manifolds with Stokes' Theorem. Students move from the extrinsic geometry of curves and surfaces to the intrinsic geometry of manifolds. Applications include spacetime in general relativity and Hamiltonian mechanics.
Thesis			
Code	**Title**	**Credits**	**Description**
MATH649	Thesis (I)	**3**	This course is intended for master's-level students to develop their master's thesis and complete its first draft. Students are expected to prepare an initial research proposal and provide a detailed outline of the proposed research, including the research objectives, methodology, expected results, and other relevant components. The first draft should include both the preliminary pages and the main body of the thesis. The preliminary pages should comprise the title page, copyright page, dedication, acknowledgments, abstract, table of contents, list of tables, and list of figures, as well as the initial expected results. Finally, students should submit a written report reflecting on their activities and performance throughout the semester.

MATH699	Thesis (II)	**3**	Thesis II is an advanced research course in which students independently develop and complete a scholarly master's thesis under the guidance of a supervisor and program coordinator. Students deepen their expertise in a defined research topic, apply appropriate scientific methods—including analytical reasoning, computation, simulation, exploration, and proof construction—to address a research problem, and critically evaluate and communicate their findings. The thesis is prepared in accordance with the requirements of the Master's Thesis Manual and culminates in a formal presentation and defense before an examining committee and the academic community.
Electives			
Code	**Title**	**Credits**	**Description**
MATH500	Complex Analysis	**3**	This graduate course introduces advanced topics in complex analysis and emphasizes the distinctive properties of analytic (holomorphic) functions. Topics include Cauchy's integral theory, Laurent series and singularities, the Residue Theorem and applications to improper integrals and inverse Laplace transforms, the argument principle, Rouché's Theorem, winding numbers, Möbius transformations, mappings by z^2 and branches of $\sqrt{z}$, conformal mappings, applications of conformal mappings to physical problems, and Riemann surfaces.
MATH518	Topics in Number Theory	**3**	This course introduces fundamental and advanced topics in number theory, including Diophantine equations, Pell-type equations, recurrence relations, and elliptic curves. It develops analytical and computational techniques for solving mathematical problems and explores applications in finite fields, integer factorization, and cryptography. Emphasis is placed on mathematical reasoning, problem-solving, and rigorous proof.
MATH540	Partial Differential Equations	**3**	This course develops the modern theory of partial differential equations following Evans' textbook, starting from the theory of Sobolev spaces and proceeding to weak solutions of elliptic, parabolic, and hyperbolic equations. The course covers weak differentiability, Sobolev embedding theorems, trace theorems, the Lax–Milgram theorem, elliptic regularity, maximum principles, eigenvalue problems, Galerkin methods for evolution equations, and an introduction to semigroup theory.
MATH545	Ordinary Differential Equations	**3**	This course covers the fundamental theory of ordinary differential equations at an advanced level. It proves key results for the initial value problem, mainly the Cauchy–Lipschitz theorem, which gives existence, uniqueness, extensibility, and continuous dependence on initial conditions. It also introduces delay differential equations and the analytical tools used to study the qualitative behavior and stability of these systems.
MATH555	Dynamical Systems	**3**	Math555 is an introductory course in dynamical systems with an emphasis on analytical and qualitative methods for linear and nonlinear differential equations. It gives an introduction to the study of dynamical systems, the interdisciplinary field of applied mathematics that studies systems that change over time. Complicated behavior can arise from simple models. Elementary dynamical systems do not necessarily yield simple results. In particular, we will see that simple initial behavior can produce patterns that have surprising structures.
MATH556	Matrix Theory	**3**	Matrix theory develops the main results and techniques for analyzing the structure of matrices. After a review of vector spaces, determinants, eigenvalues and inner product spaces, students study partitioned matrices, ranks and eigenvalues, the Geršgorin disc theorem, matrix decompositions and the Jordan canonical form, numerical ranges, matrix norms, and the Kronecker and Hadamard products. The final part covers special classes of matrices and unitary, contractive and positive semidefinite matrices, including the Schur complement and determinant inequalities. Emphasis is on rigorous proof and computation; majorization is optional advanced material if time permits.
MATH583	Topics In Mathematics	**3**	Fractional calculus generalizes derivatives and integrals to non-integer orders and is widely used to model real-world phenomena. Students study the Riemann–Liouville fractional integral and differential operators, the Caputo derivative, and the Mittag-Leffler functions used to formulate and solve fractional differential equations. Further topics are existence and uniqueness theorems with analytical and numerical solution techniques, generalized and nonclassical fractional derivatives and integrals, the dependence of solutions on initial conditions, and the stability of fractional systems. Any change to the selected topics will be reflected in the syllabus content.

MATH585	Topics In Applied Mathematics	**3**	Fractional calculus extends differentiation and integration to arbitrary, non-integer orders. Starting from the Riemann–Liouville and Caputo operators, students study fractional integrals and derivatives, the Gamma, Beta and Mittag–Leffler functions, fractional Laplace transforms, and Cauchy-type problems for fractional differential equations. Further topics are the existence and uniqueness of solutions, fractional Green's functions, and integro-differential equations with weakly singular kernels. Students learn to formulate, analyze and solve fractional models arising in mathematics and the applied sciences. Any change to the selected topics will be reflected in the syllabus content.