MATHEMATICS

CURRICULUM

Master of Science in Applied Mathematics

DEGREE REQUIREMENTS		Credits
AM8000	Master's Seminar	Pass/Fail
AM8101	Principles and Techniques	1
AM8102	Advanced Numerical Analysis	1
One Foundation course		1

AND one of the following Options:

Thesis Option

	Master's Thesis	Milestone
	Two electives from the Electives list or the remaining Foundation course	2

Major Research Paper Option

	Major Research Paper	Milestone
	Four electives from the Electives list or the remaining Foundation course or other approved graduate courses	4

Doctor of Philosophy in Mathematical Modelling and Methods

DEGREE REQUIREMENTS		
Candidacy Examination		(Milestone)
Dissertation		(Milestone)
AM9000	PhD Seminar	Pass/Fail
3 Electives		3

Foundation Courses		Credits
AM8001	Analysis and Probability	1
AM8002	Discrete Mathematics and its Applications	1

Electives		Credits
AM8201	Financial Mathematics	1
AM8204	Topics in Discrete Mathematics	1
AM8205	Applied Statistical Methods	1
AM8206	Partial Differential Equations	1
AM8207	Topics in Biomathematics	1
AM8208	Topics in Mathematics	1
AM8209	Directed Studies in Math	1
AM8210	Mathematical Biology	1
AM8211	Non-Linear Programming and Applications	1
AM8212	Introduction to Fluid Dynamics	1
AM8213	Financial Mathematics II	1
AM8214	Computational Complexity	1
AM8215	Stochastic Processes	1
AM9000	PhD Seminar	1
AM9001	Advanced Topics in Discrete Mathematics	1
AM9002	Advanced Topics in Financial Mathematics	1
AM9003	Advanced Topics in Biomathematics and Fluids	1
AM9004	Dir. Studies Math Model/Method	1

COURSE LISTING

Candidacy Examination (Doctoral)
This is a "Milestone". Pass/Fail

Doctoral Dissertation
This is a "Milestone". Pass/Fail

Master's Thesis
This is a "Milestone." Pass/Fail

Major Research Paper
This is a "Milestone." Pass/Fail

AM8000 Master's Seminar
The course consists of regular research seminars in the general area of applied mathematics, given by graduate students, faculty members, visiting scholars, and guest speakers. In order to pass this course, each student is normally expected to attend seminars during each term in the program, for a maximum of four terms, and to give one presentation. Pass/Fail.

AM8001 Analysis and Probability
Topics to be covered will be taken from the following list: metric spaces, Banach and Hilbert Spaces, measure spaces, integration, functional spaces and operators, random variables and conditional expectation; modes of convergence, discrete time martingales and filtrations; Brownian motion, continuous time stochastic processes and martingales; stochastic calculus. 1 Credit

AM8002 Discrete Mathematics and its Applications
Selected topics from discrete mathematics: graph isomorphisms and homomorphisms; Ramsey theory, random graphs; infinite graphs; automorphism groups; graph searching games (such as Cops and Robbers); Steiner triple systems; graph decompositions; Latin squares; finite fields; polynomial rings; finite projective and affine planes. 1 Credit

AM8101 Principles and Techniques in Applied Math
Asymptotic Expansions; Perturbation Methods; Eigenfunction Expansions; Integral Transforms; Discrete Fourier Transforms. 1 Credit

AM8102 Advanced Numerical Analysis
Numerical methods; numerical linear algebra; numerical methods for ODEs; numerical methods for PDEs. 1 Credit

AM8201 Financial Mathematics
This course covers the fundamentals of mathematical methods in finance. After providing a background in Stochastic Calculus, it considers the study of financial derivatives. Fixed income instruments, derivative pricing in discrete and continuous time, including Black-Scholes formulation, American and Exotic options are considered. Elements of Portfolio Management and Capital Asset Pricing Model are also taken into account. 1 Credit

AM8204 Topics in Discrete Mathematics
Selected advanced topics from discrete mathematics: random graphs; models of complex networks; homomorphisms and constraint satisfaction; adjacency properties; Ramsey theory; graph searching games; Latin squares; designs, coverings, arrays, and their applications. 1 Credit

AM8205 Applied Statistical Methods
This course covers a wide variety of statistical methods with application in medicine, engineering, and economics. Exploratory data analysis. Parametric probability distributions. Sampling and experimental designs. Estimation, confidence intervals and tests of hypothesis. Analysis of variance. Multiple regression analysis, tests for normality. Nonparametric statistics. Statistical analysis of time series; ARMA and GARCH processes. Practical techniques for the analysis of multivariate data; principal components, factor analysis. 1 Credit

AM8206 Partial Differential Equations
Topics to be covered will be taken from the following list: Derivation of equations from conservation laws; First-order Equations and the Method of Characteristics; Weak Solutions; Hyperbolic Systems; Diffusion and Reaction-Diffusion Equations; Traveling Wave Solutions; Elliptic Equations. 1 Credit

AM8207 Topics in Biomathematics
Discrete and continuous time processes applied to biology and chemistry. Deterministic and stochastic descriptions for birth/death processes in chemical kinetics. Numerical methods for spatially distributed systems including multi-species reaction-diffusion equations. Applications will include some or all of: chemical waves, traveling wave fronts in excitable media, spiral waves, pattern formation, blood flow and flow in chemical reactors. 1 Credit

AM8208 Topics in Mathematics
The topics in this course will vary each time it is offered as it will depend on the professor teaching it and the topics that interest the students. 1 Credit

AM8209 Directed Studies in Mathematics
This course is for students who wish to gain knowledge in a specific area for which no graduate level classes are available. Students who are approved to take the course are assigned a suitable class advisor most familiar with the proposed content. Students are required to present the work of one term (not less than 90 hours in the form of directed research, tutorials and individual study) in an organized format. 1 Credit

AM8210 Mathematical Biology
Linear and nonlinear differential equations, Routh-Hurwitz criteria, local stability, phase-plane analysis, bifurcations and global stability. Applications including some of predator-prey models, epidemic models, competition models and spruce budworm models. New journal research papers related to these models. 1 Credit

AM8211 Non-Linear Programming and Applications
Quadratic Optimization, Non-Linear Optimization, Optimality Conditions, Karush-Kuhn-Tucker Theorem, Numerical Methods (Descent Direction, Newton's), Portfolio Optimization, Markowitz Efficient Frontier, Capital Market Line, Sharpe Ratio. Antirequisite: MTH603

AM8212 Introduction to Fluid Dynamics
We derive equations governing fluid flows from the basic physical conservation laws. Exact analytic solutions to various elementary flow problems are obtained. We consider viscous flow, irrotational flow, boundary layers and water waves. Flow instability will also be examined. Mathematical results are related to phenomena observed in aerodynamics, flow through conduits and geophysical flows. Antirequisite: MTH732 1 Credit

AM8213 Financial Mathematics II
The course covers fixed income derivatives and the quantitative aspects of risk and portfolio management in modern finance. It introduces single factor interest rate models and pricing and covers analysis of risk measures and their properties, market, credit risk and an overview of other types of risks. The course also develops portfolio optimization techniques. Case studies and preparation for financial certification programs (FRM and PRM) are also included. Antirequisite: MTH800 1 Credit

AM8214 Computational Complexity
Order of Growth notation, time and space complexities of DTMs and NDTMs, intractability, basic complexity classes, P=NP?, reducibility and completeness, NP-completeness, Cook's theorem, hierarchy results, circuit complexity, probabilistic algorithms, models for parallel computation. Antirequisite: MTH814 1 Credit

AM8215 Stochastic Processes
This course provides a brief and broad introduction to various important stochastic processes that lie at the heart of stochastic analysis and modelling. Topics to be covered include Bernoulli processes, random walks, Poisson processes, Markov processes, Martingales, Brownian motions. 1 credit

AM9000: PhD Seminar
This course features presentations by guest speakers and PhD students. All students are required to attend and actively participate in seminars during each term in the program, for a maximum of six terms. Students will present two seminars, one of which will be on their dissertation, normally in their final year. This course aims to improve the communication skills of students. Pass/Fail.

AM9001 - Advanced Topics in Discrete Mathematics
A selection of topics from Discrete Mathematics: probabilistic method, random graph models such as binomial random graphs and random regular graphs; models of complex networks such as preferential attachment, ranking, geometric, and copying models; graph searching problems such as Cops and Robbers games, graph cleaning, and firefighting; designs, coverings, arrays, and their applications; homomorphisms and constraint satisfaction problems; combinatorial optimization problems on graphs and approximation algorithms. 1 Credit.

AM9002: Advanced Topics in Financial Mathematics
A selection of topics from the following topics in Financial Mathematics: Arbitrage pricing. Completeness and Hedging. The Martingale Approach to Arbitrage. Incomplete Markets. Exotic Derivatives. Interest Rate Models. Stochastic calculus for general semi-martingales. Levy processes. Advanced portfolio risk management. Dynamic risk measures. Advanced Credit Risk Models. 1 Credit.

AM9003: Advanced Topics in Biomathematics and Fluids
A selection of topics from Mathematical Biology and Fluid Dynamics: Review of basic fluid dynamics; hydrodynamic stability theory; mathematical modeling of blood ow and thin-film flows; biochemical networks; probability models; stochastic simulation; Markov processes; chemical and biochemical kinetics; The fixed point index, nonlinear eigenvalue problems, bifurcation, nonlinear elliptic boundary value problems; population models. 1 Credit.

AM9004 Dir. Studies Math Model/Method
This course is for PhD students who wish to gain knowledge in a specific area for which no graduate level classes are available. Students who are approved to take the course are assigned a suitable class advisor most familiar with the proposed content. Students are required to present the work of one term (not less than 90 hours in the form of directed research, tutorials and individual study) in an organized format. 1 Credit

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