MATHEMATICS (MATH)

Courses

MATH 510 FUNCTIONS AND MODELING FOR SECONDARY SCHOOL TEACHERS (3)

Engagement in explorations of mathematics to broaden and deepen content knowledge, emphasizing concepts needed to teach secondary mathematics at various levels. Investigations into mathematical topics including regressions in modeling; functions, rates, and patterns; and functions in other systems, with an emphasis on written communication about mathematical ideas and models. Prerequisites: MATH 273, MATH 274, and MATH 265 or equivalent.

MATH 512 THEORY OF INTEREST (4)

The mathematical theory and applications of key financial management concepts and procedures including interest, force, annuities, perpetuities, amortization of loans, bonds, stocks, approximating yields, the term structure of interest rates, duration, convexity, asset matching, swaps, and determinants of interest. Prerequisite: MATH 274.

MATH 523 TEACHING MATHEMATICS IN THE SECONDARY SCHOOLS (3)

Best practices for teaching mathematics at the secondary level; analysis and application of methods for planning, conducting, and reflecting on mathematics instruction and assessment. Prerequisites: admission to the MTED-MS program; not open to students who have previously completed MATH 423 (or its equivalent).

MATH 525 MATHEMATICAL PROBLEM SOLVING FOR TEACHERS (3)

A problem-solving seminar designed for teachers to build their understanding of mathematics content and analytical skills. Problems solving strategies will be applied to a variety of challenging problems, related to topics from middle and high school mathematics curricula. An important focus of the course is oral and written justifications of solutions. Prerequisites: admission to the Mathematics Education M.S. program; MATH 273 or its equivalent; not open to students who have previously completed MATH 325 or its equivalent.

MATH 531 PROBABILITY (4)

Probability in sample spaces, discrete and continuous random variables, distribution theory, Tchebychev's theorem, central limit theorem, expected values and moments. Prerequisite: MATH 274.

MATH 532 MATHEMATICAL STATISTICS (3)

Sample theory and distributions, point estimation, confidence intervals, tests of hypothesis, regression, correlation and analysis of variance. Prerequisite: MATH 331 (MATH 531).

MATH 533 APPLIED REGRESSION AND TIME SERIES PREDICTIVE MODELING (4)

Simple and multiple regression models, least squares estimates, hypothesis testing, confidence intervals and prediction intervals, model building methods and diagnostic checking. Non-seasonal time series models: autoregressive, moving-average, autoregressive moving-average, and/or autoregressive integrated moving-average models, parameter estimation and forecasting. Minitab or a similar software is used for real data analysis. Prerequisite: MATH 265 or equivalent and MATH 332/MATH 532 or equivalent.

MATH 535 NUMERICAL ANALYSIS I (3)

Error analysis, interpolation, numerical differentiation and integration, numerical solution of algebraic equations and of systems of algebraic equations.

MATH 537 OPERATIONS RESEARCH (3)

Introduction to linear, integer and nonlinear programming; the simplex method and interior point methods, duality and sensitivity analysis: formulation of optimizations models and applications to problems from industry. Prerequisites: MATH 211 or MATH 273 and MATH 265.

MATH 538 FUNDAMENTALS OF LONG-TERM ACTUARIAL MATHEMATICS (4)

Mathematical foundations of life contingencies and their applications to the long-term insurance coverages, including life insurance, life annuities and pension plans. Topics include mortality models and mortality improvement; life tables; survival estimation; probabilities, means, variances and covariance for the present value random variables associated with life insurance and life annuity products on single lives; premium calculation based on the actuarial equivalence principle, portfolio percentile principles, and for a given expected present value of profit; policy values calculation, profit and gain by source, modified premium reserves; profit analysis and profit testing. Not open to students who successfully completed MATH 438. Prerequisites: MATH 312 or MATH 512 and MATH 331 or MATH 531.

MATH 541 FUNDAMENTALS OF SHORT-TERM ACTUARIAL MATHEMATICS (3)

Insurance and reinsurance coverages; severity, frequency, and aggregate models; parametric estimation; introduction to credibility; introduction to pricing and reserving for short-term insurance coverages. Not open to students who successfully completed MATH 441. Prerequisite: MATH 331 or MATH 531.

MATH 542 ADVANCED SHORT-TERM ACTUARIAL MATHEMATICS (3)

Advanced severity, frequency, and aggregate models; coverage modifications; construction and selection of parametric models; credibility; pricing and reserving for short-term insurance coverages. Not open to students who successfully completed MATH 442. Prerequisite: MATH 332 or MATH 532.

MATH 547 STATISTICS FOR RISK MODELING (3)

The theory and applications of key statistics for risk modeling concepts and procedures including supervised versus unsupervised learning, regression versus classification, the common methods of assessing model accuracy, data checking and validation, generalized linear models, principal component analysis, decision tree models, bagging, boosting, and random forests, cluster analysis, K-means clustering, and hierarchical clustering. R or a similar software package is used for data analysis. Not open to students who have successfully completed MATH 447. Prerequisite: MATH 533 (may be taken concurrently with MATH 533).

MATH 548 ADVANCED LONG-TERM ACTUARIAL MATHEMATICS (3)

Advanced actuarial models for long-term insurance coverage. Topics include survival models for multiple state contingent cash flows to single lives and joint lives; multiple state dependent insurance and annuity present value random variables and their expectation; premium and policy valuation for long-term state-contingent coverage; multiple state model estimation and the construction of multiple decrement models; pension plans and retirement health benefits; embedded options in life insurance and annuity products. Not open to students who have successfully completed MATH 448. Prerequisite: MATH 438 or MATH 538.

MATH 551 GRAPH THEORY (3)

Hamiltonian and Eulerian graphs, coloring graphs, planar and non-planar graphs, connectivity problems; isomorphic graphs and advanced topics.

MATH 557 DIFFERENTIAL GEOMETRY (3)

Curvatures of curves and surfaces in E3, geodesics, invariants, mappings and special surfaces. Prerequisites: MATH 275 Calculus III and MATH 265 Eled. Linear Algebra.

MATH 563 LINEAR ALGEBRA (3)

Vector spaces over arbitrary fields, linear transformations, eigenvalues, eigenvectors, inner products, bilinear forms, direct sum decompositions and the Jordian form.

MATH 565 NUMBER THEORY (3)

An introduction to elementary number theory: prime numbers, prime factorization, modular arithmetic, arithmetic functions, primitive roots, and quadratic residues. Additional topics may include: elliptic curves, Diophantine equations, sums of squares, the distribution of primes, and applications. Prerequisites: either MATH 263 or MATH 267; and MATH 274.

MATH 568 ALGEBRAIC STRUCTURES (3)

Topics include groups, solvability and insolvability of polynomials, principal ideal, Euclidean, and unique factorization domains.

MATH 574 DIFFERENTIAL EQUATIONS (3)

Theory and application of linear ordinary differential equations. Solutions of nonlinear ordinary differential equations of the first order. Prerequisite: MATH 274.

MATH 575 MATHEMATICAL MODELS (3)

Consideration of some mathematical problems in sociology, psychology, economics, management science and ecology, and developing appropriate mathematical models and techniques to solve them.

MATH 576 INTRODUCTORY REAL ANALYSIS (4)

Introduction to mathematical analysis. Sequence series, continuity, differentiation, integration and uniform convergence. Prerequisites: MATH 267 and MATH 275.

MATH 577 COMPLEX ANALYSIS (3)

Complex number system, analytic functions, Cauchy's integral theorem and integral formula, Taylor and Laurent series, isolated singularities, Cauchy's residue theorem and conformal mappings. Prerequisite: MATH 275.

MATH 578 TOPOLOGY (3)

Basic concepts of point set topology, separation axioms, compact and connected spaces, product and quotient spaces, convergence, continuity and homeomorphisms.

MATH 579 FOURIER ANALYSIS WITH APPLICATIONS (3)

Vector, integral and differential calculus including the divergence and Stoke's theorems. Fourier series, orthogonal functions and applications. Prerequisite: MATH 275.

MATH 580 SELECTED TOPICS IN MATHEMATICS (1-4)

Topics will be chosen from different areas in mathematics. Content will be determined so as to complement course offerings, as well as the needs and desires of the students. May be repeated for a maximum of 9 units provided a different topic is covered each time. Prerequisite will vary from topic to topic.

MATH 585 MATHEMATICAL FINANCE (3)

Mathematical theory, computation and practical application of derivatives in managing financial risk. Parity and option relationships, binomial option pricing, the Black-Scholes equation and formula, option Greeks, market-making and delta-hedgind, exotic options, lognormal distribution, Brownian motion and ITO's lemma, interest rate models. Computer laboratory activities throughout. Prerequisite: MATH 331.

MATH 586 RISK MANAGEMENT AND FINANCIAL ENGINEERING (3)

Mean-variance portfolio theory, asset pricing models, market efficiency and behavioral finance, investment risk and project analysis, capital structures, Cash flow engineering, Monte Carlo methods, statistical analysis of simulated data, risk measures, framework for fixed income engineering, portfolio management, change of measures and Girsanov Theorem and tools for volatility engineering. Computer laboratory activities throughout. Prerequisite: MATH 585 or equivalent or consent of department.

MATH 601 INTRODUCTION TO STATISTICAL COMPUTING AND DATA SCIENCE (3)

Fundamental topics of statistical data science with an emphasis on statistical computing tools, such as R, or SAS, or SPSS, etc, and numerical methods. Topics include the data science project lifecycle, data wrangling, data transformation, data exploration, and numerical methods for statistical inference. This course has been offered as a special topic; students who have earned credit for this course as a special topic will not receive additional credit for MATH 601. Prerequisite: MATH 330 or equivalent.

MATH 602 MATHEMATICS IN SOCIETY: PAST AND PRESENT (3)

Investigations in how mathematics and math education intersect with political and social life through historical and contemporary contexts. Particular attention will be paid to authentic mathematics problems from a variety of socio-cultural and community-based contexts and to using mathematics to teach and learn about issues of social and economic justice.

MATH 605 CONDUCTING EFFECTIVE MATHEMATICS PROFESSIONAL DEVELOPMENT (3)

Principles of planning, enacting, and reflecting on effective professional development for mathematics teachers. Includes attention to working with adult learners, fostering professional learning communities, developing teachers' mathematical knowledge for teaching, advancing equity and social justice through professional development, and adapting professional development to support local goals and interests.

MATH 606 PROBABILITY THEORY AND APPLICATIONS FOR TEACHERS (3)

An introduction to the study of uncertainty, including basic concepts of probability, conditional probability, discrete and continuous random variables, expected values, and moments. Applications of probability to a variety of mathematical and real-world scenarios will be emphasized. Prerequisites: MATH 274 (Calculus II) or equivalent, and program admission.

MATH 620 TECHNOLOGY FOR MATHEMATICS TEACHING AND LEARNING (3)

Development of technological expertise and its combination with pedagogical and content knowledge for the application of technology use in classrooms to develop student conceptual understanding of mathematics. Specific technologies for study will be chosen based on current use in school settings, and may include calculators, computers, mathematics software and apps, or other tools.

MATH 621 SEMINAR IN TEACHING ELEMENTARY/ MIDDLE SCHOOL MATHEMATICS (3)

Analysis of pedagogical methods and materials in elementary and middle school mathematics instruction and assessment. Mathematics topics include, but are not limited to, those taught in grades 1 – 8. Prerequisites: MATH 204, MATH 205, and MATH 251, or their equivalents.

MATH 622 SEMINAR IN TEACHING ADVANCED PLACEMENT CALCULUS (3)

Discussion and analysis of materials, pedagogy, and technology for the teaching of Advanced Placement Calculus in high schools. Prerequisites: admitted into the MS program in Mathematics Education or the consent of the instructor.

MATH 623 INVESTIGATING STUDENT THINKING IN MATHEMATICS (3)

Theory and strategies for eliciting, interpreting, and using student thinking within the mathematics classroom in order to create opportunities for student-centered learning and teaching of mathematics. Includes a focus on analyzing student work, understanding student thinking, and using that understanding to guide subsequent interactions with the student. Current literature on mathematics education to build models of students' thinking about mathematical concepts in K-12.

MATH 624 EUCLIDEAN AND NON-EUCLIDEAN GEOMETRY THROUGH AN INQUIRY APPROACH (3)

An exploration and comparison of the geometry of Euclidean and Non-Euclidean surfaces, including spherical geometry. Problem solving, problem posing, and the use of physical and technological models will be integrated throughout. Prerequisite: admission to the Mathematics Education M.S. program.

MATH 625 ADVANCED PEDAGOGY FOR SECONDARY MATHEMATICS (3)

In-depth investigations of pedagogical techniques for middle and high school mathematics teachers. Includes study of current curricula, research results, assessment, and integration of materials and technology in instruction. Prerequisite: MATH 423 or MATH 425, or equivalent.

MATH 626 MAKERSPACE TECHNOLOGY IN SCHOOL MATHEMATICS (3)

Development of technological expertise and its combination with pedagogical and content knowledge to form an integrated understanding of makerspace technology use in the mathematics classroom (technological pedagogical content knowledge or TPACK). Specific technologies for study will be chosen based on current makerspace use in school settings, and may include digital fabrication tools, robotics, microcontrollers, and other emerging technology.

MATH 627 CURRICULUM ISSUES IN SECONDARY SCHOOL MATHEMATICS (3)

Analyze secondary school mathematics curriculum development from a historical perspective and discuss past influences on current methodology. Distinguish current curriculum trends and design alternatives. Evaluate contemporary curriculum by assessing an existing text or program. Create a selected mathematics unit. Prerequisite: MATH 625.

MATH 628 REAL ANALYSIS FOR TEACHERS (3)

Principles underlying calculus, including topics in real analysis such as completeness for the reals, limits, continuity, differentiation/integration, sequences and series. Emphasis on mathematical theory and the pedagogy of teaching functions. Precalculus and calculus in the secondary school. Prerequisites: Admission to the master's program in Mathematics Education (or approval of department), MATH 273 and MATH 274 or equivalent.

MATH 629 UNDERSTANDING AND USING MATHEMATICS EDUCATION RESEARCH (3)

Introduction to the theory and methodology of mathematics education research, including quantitative and qualitative designs. Students will gain experience in reading and interpreting mathematics education research, with a specific focus on applying research findings to classroom practice. Prerequisite: admission to the Mathematics Education M.S. program.

MATH 630 STATISTICS THEORY AND APPLICATIONS FOR TEACHERS (3)

An introduction to the study of uncertainty, covering concepts of sampling and experimental design; descriptive statistics, including graphical representations and numerical summaries; basic probability; inferential statistics, including sampling distributions, confidence intervals, and parametric and non-parametric hypothesis; and linear regression. Issues concerning the pedagogy of statistics will be woven throughout the course, as will various statistical software packages.

MATH 631 TOPICS IN PROBABILITY (3)

Review of basic probability theory, types of convergence and limit theorems, elementary stochastic processes. Markov chains, birth and death processes. Gaussian processes. Examples from engineering, physical and social sciences, management and statistics. Prerequisite: MATH 331.

MATH 632 COMPUTATIONAL STOCHASTIC MODELING (3)

Computing expectations and probabilities by conditioning. Markov chains: classification of states, limiting probabilities, gambler's ruin problems, algorithmic efficiency, branching process, time-variable Markov chains, continuous-time Markov chains, birth and death processes, Kolmogrov differential equations, uninformization. Renewal theory and its applications. Prerequisite: MATH 331, MATH 531, or consent of chairperson.

MATH 634 TIME SERIES ANALYSIS AND FORECASTING (3)

An introduction to statistical models for time series analysis and forecasting. Topics include time series decompositions, exponential smoothing, dynamic regression, spectral analysis and filtering. A variety of models will be discussed including the Holt, Holt-Winters, ARMA, ARIMA, SARIMA, and state-space models. Prerequisites: MATH 265 and MATH 332, or MATH 532, or consent of department chair.

MATH 635 APPLIED NUMERICAL ANALYSIS (3)

Direct and iterative methods for solving linear systems. Newton's method. Solution of ordinary differential equations, including Euler's method, Runge-Kutta methods, Adams-Bashforth methods and Adams-Moulton methods. Stability analysis. Finite difference methods for the solution of partial differential equations. Prerequisites: MATH 374 or MATH 574, and MATH 435 or MATH 535, or consent of chairperson.

MATH 636 LINEAR AND NONLINEAR PROGRAMMING (3)

Formulations and model building in linear programming. The simplex method and its variants: duality theory, sensitivity analysis, polynomial time algorithms, multiobjective optimization models and algorithms. Prerequisite: MATH 265, MATH 275 and graduate standing, or consent of chairperson.

MATH 637 ADVANCED TOPICS IN APPLIED OPERATIONS RESEARCH (3)

Dynamic programming, formulation of deterministic decision-process problems, analytic and computational methods of solution, application to problems of equipment replacement, resource allocation, scheduling, search and routing. Brief introduction to decision making under risk and uncertainty. Prerequisites: MATH 275 and MATH 331, or MATH 531, or consent of chairperson.

MATH 638 APPLIED MULTIVARIATE STATISTICAL ANALYSIS (3)

A brief review of vector and matrix algebra and an introduction to applications of multivariate statistical methods. Multivariate normal distribution and its properties, inference for mean vector of a multivariant normal distribution, and simultaneous inference for components of the mean vector. Principle components, factor analysis, and discrimination & classifications. The course introduces many applications of the topics related to real world problems in the fields of engineering, sciences, and business. Minitab or a similar software is used for real data analysis. Prerequisites: MATH 531 or equivalent, MATH 533 or equivalent, MATH 265 or equivalent.

MATH 639 LOSS MODELS (4)

Severity models, frequency models, aggregate models, survival models, construction of parametric models, and credibility models. Prerequisites: MATH 532 or equivalent.

MATH 640 BAYESIAN STATISTICS (3)

An introduction to fundamental concepts and methods of Bayesian data analysis. Modern Bayesian computing algorithms will be emphasized and implemented using related software such as R. Applications of Bayesian data analysis will be discussed. Prerequisite: MATH 532 or equivalent.

MATH 641 ENTERPRISE RISK MANAGEMENT (3)

Covers part of the syllabus of the Enterprise Risk Management exam offered by Society of Actuaries. Serves as an introduction to Enterprise Risk Management. It will define and categorize different types of risks an entity faces, and define an ERM framework. Ways to measure and quantify the risk, such as (principle based) Economic Capital, Value at Risk (VaR), and stress scenarios will be analyzed and compared. The course will conclude with applications of these methods in a case study of an insurance company and recent regulatory developments. Prerequisite: Pass Exam P or MATH 331/ MATH 531.

MATH 642 CREDIBILITY AND SIMULATION (3)

Techniques of modeling and simulation including limited fluctuation (classical) credibility, Bayesian credibility, conjugate priors, Buhlmann and Buhlmann-Straub models, and empirical Bayes methods in the nonparametric and semiparametric cases. Prerequisite: MATH 332 or MATH 532.

MATH 643 COMPUTATIONAL METHODS OF MATHEMATICAL FINANCE (3)

Computation techniques involving tree method, finite difference scheme, Monte Carlo simulation, term structure fitting and modeling, financial derivative pricing, the Greeks of options, Capital Asset Pricing Model, Value-at Risk calculation. Software package such as Mathematica or Excel will be used. Prerequisites: MATH 585 or equivalent.

MATH 644 MATHEMATICS OF FINANCIAL DERIVATIVES (3)

Modern pricing theory for financial derivatives, stochastic differential equations, Ito formula, martingales, Girsanov Theorem, Feynman-Kac PDE, term structure, Interest-Rate models and derivatives, optimal stopping and American options. Prerequisites: MATH 585 , or equivalent.

MATH 645 STATISTICAL THEORY I (3)

Random variables and their distributions, Bayes' theorem, types of convergence, the law of large numbers, the central limit theorem, the normal distribution and related distributions, survey sampling, estimation of parameters and fitting of probability distributions, hypothesis tests, and assessing goodness of fit. If time permits, more advanced topics including nonparametric analysis and bootstrap resampling will also be introduced. Prerequisites: MATH 265 and MATH 275, or equivalent.

MATH 646 REGRESSION ANALYSIS (3)

Theoretical and applied aspects of regression analysis including linear regression, generalized linear models, model selection, multicollinearity, leverage points, transformations, AIC, BIC, AICC, ANOVA tests, serially correlated errors, logistic regression, deviance, and simple models for stationary time series. Prerequisites: MATH 330 or equivalent.

MATH 647 PREDICTIVE ANALYTICS (3)

Principles and methodologies of predictive modeling. Topics include prediction versus interpretation; assessing model accuracy; resampling methods; bootstrapping; subset selection; shrinkage methods; dimension reduction methods; the logistic model; bagging; random forests; principal component analysis; clustering methods. R, SAS, SPSS or a similar software package will be used for data analysis. Prerequisite: MATH 337 or MATH 533.

MATH 653 TOPICS IN GEOMETRY (3)

Axiomatic development of Euclidean, elliptic and hyperbolic geometries; the study of the analytic plane, the sphere and the Poincare model as models for these axiomatic systems. Not open to students who have had MATH 353. Prerequisites: MATH 274 and MATH 467 (or MATH 568).

MATH 668 COMPUTATIONAL TOPOLOGY (3)

The homology of a simplicial complex and the notion of persistence in a sequence of simplicial complexes; implementing persistent homology; applications to biology, data clustering, and denoising.

MATH 671 CHAOTIC DYNAMICS AND FRACTAL GEOMETRY (3)

Introduction to the classical theory of linear systems and the modern theory of nonlinear and chaotic systems. Modeling of discrete and continuous time systems. Bifurcation theory, symbolic dynamics, fractals and complex dynamics, Julia sets and the Mandelbrot set. Mathematica or an equivalent software package will be used. Prerequisites: MATH 265 and MATH 275, and graduate standing or consent of chairperson.

MATH 673 INTEGRAL TRANSFORMS AND APPLICATIONS (3)

Integral transforms and their applications: Fourier, Laplace, Hankel, Mellin, and z-transforms and their applications for solving ordinary differential equations, partial differential equations, integral equations, and difference equations arisen from physics, engineering and sciences. Prerequisites: MATH 374, (or MATH 574) and MATH 379 (or MATH 579); and MATH 475 (or MATH 577); or consent of chairperson.

MATH 674 APPLIED PARTIAL DIFFERENTIAL EQUATIONS (3)

Discussions of the typical partial differential equations of applied mathematical physics: Heat equations. Wave equations, Beam equations, Laplace equations. Separation of variables, variation of parameters and Fourier transform for initial and boundary value problems, Calculus of variation and Ritz-Galerkin's numerical method. Prerequisite: MATH 374 (or MATH 574), MATH 379 (or MATH 579), or consent of chairperson.

MATH 675 ASYMPTOTIC AND PERTURBATION ANALYSIS (3)

Asymptotic series and asymptotic methods for approximating solutions to linear and nonlinear ordinary differential equations. Asymptotic expansion of integrals; Watson's Lemma. Perturbation series; regular and singular perturbation theory. Boundary layer theory for ordinary differential equations. Prerequisites: MATH 374/ MATH 574 or equivalent and MATH 475/ MATH 577 or equivalent.

MATH 676 INTRODUCTION TO MATHEMATICAL CONTROL THEORY (3)

Problems and specific models of mathematical control theory. Elememnts of classical control theory: controllability, observability, stability, stabilizability and realization theory for linear and nonlinear systems. Optimal control, Maximum Principle and the existence of optimal strategies. Prerequisites: MATH 265 and MATH 374/MATH 574.

MATH 677 ADVANCED MATHEMATICAL MODELING (3)

Development of appropriate stochastic as well as deterministic models to solve applied mathematical problems in the fields of physics, engineering, and the social sciences. Topics include optimization models, dynamic models, probability models and Monte Carlo simulation. Mathematica or a similar software package will be used. Prerequisites: MATH 331 or MATH 531, and MATH 379 or MATH 579, or consent of chairperson.

MATH 680 SPECIAL TOPICS IN MATHEMATICS EDUCATION (3)

Topics will be chosen focusing on pedagogy, educational theories, curriculum, research, policy, or other issues of mathematics education. Content will be determined to complement graduate course offerings in mathematics education. May be repeated for a total of 9 units provided a different topic is taken each time. Prerequisite: program admission.

MATH 681 SPECIAL TOPICS IN MATHEMATICS FOR TEACHERS (3)

Topics will be chosen from a mathematical field related to, or extending, the K-12 school mathematics curriculum. Content will be determined to complement graduate course offerings in mathematics education. May be repeated for a total of 9 units provided a different topic is taken each time. Prerequisite: program admission.

MATH 684 SPECIAL TOPICS IN MATHEMATICS AND STATISTICS (3)

Topics will be chosen in mathematics or statistics. Course content will be determined so as to complement course offerings in mathematics and statistics. Course may be repeated for a maximum of 8 units.

MATH 685 SPECIAL TOPICS IN APPLIED MATHEMATICS (3)

Topics will be chosen in a mathematical field not directly related to differential equations/optimization or applied statistics/mathematical finance. Course content will be determined to complement the existing course offerings. May be repeated to a maximum of 12 units provided a different topic is taken each time.

MATH 686 SPECIAL TOPICS IN DIFFERENTIAL EQUATIONS OR OPTIMIZATION (3)

Topics will be chosen in a mathematical field related to differential equations or optimization. Course content will be determined to complement the existing course offerings in the differential equations/optimization track. May be repeated to a maximum of 12 units provided a different topic is taken each time.

MATH 687 SPECIAL TOPICS IN APPLIED STATISTICS OR MATHEMATICAL FINANCE (3)

Topics will be chosen in a mathematical field related to statistics or mathematical finance. Course content will be determined to complement the existing course offerings in the applied statistics/mathematical finance track. May be repeated to a maximum of 12 units provided a different topic is taken each time.

MATH 688 TOPICS IN ACTUARIAL SCIENCE AND RISK MANAGEMENT (3)

Topics in actuarial science, risk management, and predictive analytics selected by the instructor. Selected topics include financial reporting, valuation, and management considerations for life insurance companies; capital and risk management, including securitization techniques in the insurance industry; worker's compensation programs and pricing; emerging techniques for use by actuaries; actuarial studies and communication techniques, and other topics. Prerequisite: MATH 538 or MATH 585.

MATH 695 INDEPENDENT STUDY IN MATHEMATICS (1-3)

Directed independent study in selected areas of graduate level mathematics. Prerequisite: Permission of instructor and graduate adviser.

MATH 791 MASTERS INTERNSHIP I (3)

An original investigation of a problem to be pursued in cooperation with a local industry or business under the direction of an industry supervisor and a member of the mathematics faculty. Prerequisites: Completion of at least 15 units toward the M.S. degree in Applied and Industrial Mathematics and consent of chairperson.

MATH 792 MASTER'S INTERNSHIP II (3)

An original investigation of a problem to be pursued in cooperation with a local industry or business under the direction of an industry supervisor and a member of the mathematics faculty. Prerequisites: Completion of at least 15 units toward the M.S. degree in Applied and Industrial Mathematics and consent of chairperson.

MATH 880 APPLIED MATHEMATICS GRADUATE PROJECT I (3)

An internal applied mathematics graduate project based on mutual research interests of a graduate student in the APIM program and a faculty advisor will be investigated. The advisor will guide the student throughout different phases of solving the applied mathematics problem. Prerequisites: permit required, APIM graduate students only.

MATH 881 APPLIED MATHEMATICS GRADUATE PROJECT II (3)

An internal applied mathematics graduate project based on mutual research interests of a graduate student in the APIM program and a faculty advisor will be investigated. The advisor will guide the student throughout different phases of solving the applied mathematics problem. Permit required, only APIM graduate students.

MATH 885 APPLIED MATHEMATICS GRADUATE PROJECT CONTINUUM (1)

Students who cannot complete MATH 880 MATH 881 in two semesters will then register for MATH 885, one unit, in the next semester. Except in special circumstances, MATH 885 cannot be repeated. Prerequisite: consent of the instructor.