Description of Courses

▣ Undergraduate Program

MAS100 College Mathematics

This course provides students with pre-knowledge for Calculus I(MAS101), and deals with differentiation and integration of one variable real-valued functions, emphasizing basic concepts and applications.

MAS101 Calculus I

This course deals with differentiation and integration of one variable real-valued functions, emphasizing basic concepts and applications. The topics are: differentiation and integration of trigonometric functions, logarithmic functions, hyperbolic functions and their inverse functions, improper integral and its convergence tests, polar coordinates, infinite series and their convergence tests, Taylor series, and power series.

MAS102 Calculus II

This course deals with differentiation and integration of multivariable real-valued functions, emphasizing basic concepts and applications. The topics are: vector space, inner products, cross products, matrices, determinants, cylindrical coordinates, spherical coordinates, quadratic surfaces, limits and continuity of multivariable vector-valued functions, differentiability of multivariable functions, partial derivatives, directional derivatives, tangent planes, multiple integrals, vector fields and their divergence and curl, line integrals, surface integrals, Green's theorem, Stokes' theorem, divergence theorem, and conservative vector fields.

MAS103 Honor Calculus I

This course deals with the same topics introduced in MAS101 Calculus I with more rigor.

MAS104 Honor Calculus II

This course deals with the same topics introduced in MAS102 Calculus II with more rigor.

MAS109 Introduction to Linear Algebra

This course introduces basics of linear algebra. The topics include matrices, determinants, characteristic equations, eigenvalues, eigenvectors, inner product spaces, orthogonalization, diagonalization of square matrices and quadratic forms.

MAS110 Linear Algebra for Data Science

Linear algebra for data science is a mathematical subject concerning linear equations and linear analysis of data, which is widely used in applications. The aim of this course is to provide the knowledge of linear algebra with emphasis on useful matrix theories for data science.

MAS201 Differential Equations and Applications

This course introduces the basics of differential equations. The topics include ordinary linear differential equations, Laplace transform, systems of differential equations and some partial differential equations.

MAS202 Applied Mathematical Analysis

This course introduces Fourier series, Fourier transform, differentiation and integration of complex variable functions, power series for complex variable functions, and residue theorem.

MAS210 Introduction to Number Theory

This course introduces basic number theory. Topics include congruence equations, arithmetic functions, residues, quadratic residues, continued fractions, algebraic properties of quadratic fields, the prime number theorem, diophantine approximation, diophantine equation, and applications to cryptography.

MAS212 Linear Algebra

This course gives students the opportunity to manipulate the concepts of linear algebra and to develop an intuitive understanding of their geometric meanings. Topics include unitary and hermitian mappings, eigenvalues and eigenvectors, spectral decomposition, triangulation and the Jordan normal form, and multilinear algebra.

MAS241 Analysis I

This course provides sophomores in mathematics with a thorough background in mathematical analysis. Topics include real number system, sequences, open sets, closed sets, connected sets, compact sets, limits and continuity of functions, differentiation, differentiation of multivariable functions, the mean value theorem, the intermediate value theorem, Riemann integration, sequences and series of functions.

MAS242 Analysis II

This course equips sophomores in mathematics with a further background in mathematical analysis. Topics include series of functions, uniform continuity, double series, uniform convergence, differentiation of sequences and series of functions, integration of sequences and series of functions, special functions, Hilbert space, Fourier series, orthogonality, completeness, transformations, the inverse function theorem, the implicit function theorem, vector analysis, multiple integration, line integration, and some basic concepts of differentiable manifolds.

MAS250 Probability and Statistics

This is an introduction to probability theory. Topics include independence of events and random variables, various probability distributions, expectation, conditional expectation, the law of large numbers, the central limit theorem, tests of hypothesis, the analysis of variance, and regression.

MAS260 Applied Mathematics and Modeling

This course introduces problem-oriented mathematics with case studies for real world problems.

MAS261 Computational Geometry and Computer Graphics

This course introduces mathematical methods and theories to describe curves and surfaces in space, and deals with applications to computer-aided design and computer graphics.

MAS270 Logic and Set Theory

This course introduces basic concepts of mathematical logic, the history of set theory, sets, classes, functions, relations, partially ordered sets, the axiom of choice, numbers, infinite sets, cardinal numbers, ordinal numbers, the syntax, deduction theorem, completeness, Gödel's incompleteness, and similar topics.

MAS275 Discrete Mathematics

This course introduces discrete objects, such as permutations, combinations, networks, and graphs. Topics include enumeration, partially ordered sets, generating functions, graphs, trees, and algorithms.

MAS311 Modern Algebra I

This course gives an introduction of modern and abstract algebra to mathematics majors. Topics include the elementary theory of groups, binary operations, groups and subgroups, permutation groups, cosets and Lagrange's theorem, homomorphism and factor groups, and Sylow theory: an advanced topic in group theory. It also considers the elementary theory and definitions of rings and fields, integral domains, Fermat's and Euler's theorems, the field of quotients, rings of polynomials, homomorphisms and factor rings, and the basic theory of ideals.

MAS312 Modern Algebra II

This course is a continuation of MAS311 and deals with more advanced topics, such as Sylow theory, field extensions, Galois theory, and some basic notions of module theory.

MAS321 Introduction to Differential Geometry

This course is an introduction to the differential geometry of curves and surfaces in 3-dimensional space. Topics include local theory of curves, Gauss maps and the curvature of surfaces, intrinsic geometry, and the global geometry of surfaces.

MAS331 Topology

This course studies basic general topological properties and concepts, including topologies, open sets, closed sets, compactness and connectedness, separation axioms for Hausdorff spaces, regular spaces and normal spaces, and countability. Basic properties of metric spaces and various metrization theorems are studied as well.

MAS341 Complex Variables

This rigorous treatment of the functions of a complex variable is a continuation of MAS202 Applied Mathematical Analysis. Topics include analytic functions, Cauchy's theorem, the maximum modules theorem, residue and poles, the residue theorem, the open mapping theorem, conformal mappings and applications, the Riemann mapping theorem, Schwartz-Christoffel transform, Poisson integral formula, and harmonic functions.

MAS350 Elementary Probability Theory

This course covers basic concepts and applications in probability theory. Topics include conditional probability and independence, expectation, various random variables and distributions, the law of large numbers, the central limit theorem, martingale theory, the Poisson process, Markov chains, Brownian motion, and stationary random processes. The course also includes inverse transform methods and rejection methods for simulation.

MAS355 Mathematical Statistics

This course covers basic theories for statistical methodologies and applications to engineering and applied sciences. Topics include basic theories of probability, random variables, probability distributions and their inter-relationship, average and variance, variable transformations, sampling distributions, estimation and hypothesis testing, the law of large numbers, two-dimensional distributions, decision making, linear models, and nonparametric methods.

MAS364 Matrix Computation and Application

Coming from the application of linear algebra, this course introduces the classification of matrices, according to their properties, together with the theory of matrix computations and computational algorithms.

MAS365 Introduction to Numerical Analysis

This course discusses some of the central problems that arise in applications of mathematics and the development of constructive methods for the numerical solution of the problems. It also provides elementary numerical tools for scientific computation. Topics include computing error analysis, algorithms, Gaussian elimination, Cholesky decomposition, error bounds, ill-conditioned problem, eigenvalues, Jacobi rotation and eigenvalue estimates, the power method, solution of nonlinear equations, the OR algorithm, interpolation, numerical integrations, and how to solve differential equations.

MAS370 Information Mathematics

This course introduces Shannon's information theory, computation theory, complexity theory, Hoffman code, entropy, data compression, error correcting codes, cryptography, and information security.

MAS371 Introduction to Financial Mathematics

We introduce stochastic methods that are useful for financial markets. The concepts of financial terms will be explained and stochastic methods on how the financial market products are priced will also be introduced. Through this course, students are expected to learn how probability, statistics, and applied mathematics are used in financial markets.

MAS374 Optimization Theory

This is a mathematical introduction to optimization and game theory. Topics include convex sets, convex functions, separation theorem, Karush-Kuhn-Tucker theorem, Brouwer fixed point theorem, Ky-Fan inequality, and Nash equilibrium.

MAS410 Introduction to Cryptography

This course introduces classical cryptosystems, symmetric cryptosystems, DES, AES, public key cryptosystems, digital signature, communication protocols, and information theory.

MAS411 Introduction to Algebraic Geometry

This course introduces basic concepts in algebraic geometry and related theorems for example, Bezout's theorem, Riemann-Roch theorem, and one to one correspondence theorem between projective varieties and radical ideals. Various computational problems in projective algebraic geometry using computer algebra system, e.g. Macaulay 2 or Singular are also treated.

MAS412 Introduction to Commutative Algebra

Commutative algebra is the study of commutative rings and their ideals occurring in algebraic geometry and number theory. Nowadays commutative algebra is the foundation of all modern algebra including algebraic geometry and it has many important applications in all areas of pure mathematics. This course is intended as an introduction to the theory of commutative rings.

MAS420 Analysis on Manifolds

This course covers the elementary theory of functions of several variables and introduces basic concepts of differentiable manifolds and differential forms. It considers elementary concepts in differential geometry such as manifolds, curvature and geodesics. The exterior derivative and integrals of differential forms are defined on Euclidean spaces and generalized to differentiable manifolds. The course includes applications to surface theory.

MAS430 Combinatorial Topology

This course introduces some basic algebraic topological concepts using combinatorial methods according to triangulations. Topics include simplicial complexes and triangulations of spaces, homotopy and fundamental groups, classification of surfaces, covering spaces, simplicial homology of surfaces, and the Euler-Poincare formula.

MAS435 Matrix Groups

This course provides an introduction to basic Lie group theory at the concrete level of matrix groups. Topics include general linear groups and subgroups, Lie algebras, exponentials and logarithms, maximal tori, Spin groups, and the Weyl group.

MAS440 Introduction to Partial Differential Equations

This course introduces solutions and properties of first and second order linear partial differential equations, as well as solutions of first order nonlinear partial differential equations. Laplace equations, heat equations, wave equations, and methods for boundary value problems are introduced.

MAS441 Lebesgue Integral Theory

Topics include the construction of measures on Euclidean spaces and abstract sets, the definition of Lebesgue integration, the monotone convergence theorem, Fatou's lemma, the Lebesgue dominated convergence theorem, theory of linear operators on Banach space and Hilbert space, and applications.

MAS442 Fourier Analysis and Applications

Basic properties of Fourier series and Fourier transforms will be treated with applications to differential equations and signal processing.

MAS443 Ordinary Differential Equations and Dynamical systems

We study solutions to various ordinary differential equations and geometric properties. Topics include the Poincare-Bendixon theorem, modelling, dynamical systems, and applications.

MAS455 Linear Models

This course covers methods of linear regression analysis, and major topics include simple linear regression analysis, multiple regression analysis, goodness-of-fit test, model building and model selection methods, regression analysis with incomplete data, and non-least-squares estimation.

MAS456 Statistical Methods with Computer

This course introduces data analysis methods using computer statistical program packages (Minitab, SAS, SPLUS, etc), and the main goal of the course is to teach and train students for effective analysis methods over a variety of data types and analysis purposes.

MAS457 Random Process and Signal Processing

This course introduces the fundamental methods of stochastic signal processing. It cover the topics of the definition of random processes, second moment theory, special descriptions of random processes, linear transforms, signal detection and estimation, and Gaussian processes.

MAS458 Theory and Application of Transforms

Transform theories for continuous and discrete signals are widely applied to many engineering problems. This course covers the theories and applications of various types of transform methods. We cover topics such as complex variables, contour integrals, Laplace transforms, Fourier transforms, and Z transforms.

MAS464 Mathematical Mechanics

We study mathematical models for fluids and solids. Basic concepts for viscosity, elasticity and constitutive equations are introduced.

MAS467 Introduction to Mathematical Biology

In this course, students will learn how to use mathematics to understand biological systems. Specifically, this course mainly focuses on how to use ordinary differential equations and chemical master equations (Stochastic process) to investigate biological systems from molecular to cellular, physiological, and population levels.

MAS470 Mathematical Modeling

We study mathematical modeling and mathematical analysis of various problems arising in industry. Diffusion, coagulation, conduction, transport phenomena in polymers, stochastic process, bio-medical science, crystallization, flow, heat transfer are dealt with.

MAS471 Financial Mathematics and Stochastic Models

Students learn how to price financial derivative securities in a mathematical framework. Risk-neutral measures which are fundamental for the financial mathematics are introduced. The relevant probability theory is also explained. We start with discrete-time binomial models and arrive at the continuous-time stochastic models including the famous Black-Sholes PDE.

MAS472 Computer Simulations in Financial Mathematics

This course introduces mathematical models for various financial derivatives. It also deals with computations and their numerical solutions.

MAS473 Introduction to Artificial Intelligence with Mathematics

In this course we study basic mathematics for artificial intelligence and a number of artificial intelligence algorithms including supervised learning, unsupervised learning, reinforcement learning and deep learning.

MAS475 Combinatorial Theory

This course introduces basic objects and theories of combinatorics, including permutations and combinations. It proceeds to the study of integer partitions, set partitions, partially ordered sets, generating functions, and some applications of combinatorics. No prerequisite is required, but some experience in discrete mathematics may be useful.

MAS476 Game Theory

This course covers various mathematical games, strategic games, extensive games, Nash equilibrium, and repeated games.

MAS477 Introduction to Graph Theory

This course is an introduction to some of the major topics of graph theory. They include graph connectivity, matchings, planar graphs, graph coloring, and nowhere-zero flows. The following theorems will be proved in this course: Kuratowski's thoerem on planar graphs, Tutte-Berge formula on matchings, and Menger's theorem.

MAS478 Descrete Geometry

This course will offer a concrete introduction to Discrete Geometry. Many questions in this area are about arrangements of points, lines circles spheres, in other words th emost fundamental objects of Euclidean geometry. Topics that will be covered are: basic notions of convexity, packing and covering, incidence problems, convex polytopes, Gale-duality, arrangements of hyperplanes, and approximation of convex sets by polytopes and ellipsoids.

MAS480 Topics in Mathematics

This course presents some topics which are not incorporated into regular courses. Selected topics in current trends in mathematics will be treated.

MAS481 Topics in Mathematics I

This course presents some topics which are not incorporated into regular courses. Selected topics in current trends in mathematics will be treated.

MAS482 Topics in Mathematics II

This course presents some topics which are not incorporated into regular courses. Selected topics in current trends in mathematics will be treated.

⊙ Research

MAS490 Research in Mathematics

Seniors in their final semester do research projects under the direction of their undergraduate advisors.

MAS491 (Introduction to Contemporary Mathematics)

This course guides students who aim to enter graduate school to understand recent topics in mathematical branches and to have perspectives on active areas of contemporary mathematics. In particular, topics under active research in our department will be introduced in detail.

MAS495 Individual Study

This is a special course which can be designed by students. Interested students should consult a professor and hand in a proposal.

MAS496 Mathematics Seminar

This is a seminar for mathematics majors. Registered students are expected to give presentations. The topics of the seminar vary from semester to semester.

❐ Graduate Program

MAS501 Applied Analysis and Probability for Engineers

This course introduces some basic consepts in mathematical analysis for engineering applications including topological ideas in Euclidean spaces, differentiation and integration, sequences and series, and basic probability theory.

MAS502 Functional Analysis for Engineers

Topics of this course include topological, metric, and vector spaces, linear operators on Banach and Hilbert spaces, Green's formula, applications to boundary value problems, and spectral theory of linear operators.

MAS503 Algebra for Engineers

This course introduces students to applications of algebra. Topics may include algebraic structures, graphs, Boolean algebras, groups, lattices, rings and ideals, commutative algebra, finite fields, and coding theory.

MAS504 Applied Matrix Computation

This course covers the graduate-level matrix computation and related numerical methods that are frequently used in science and engineering.

MAS510 Number Theory

Topics include number fields, Dedekind domains, decomposition of prime ideals, Galois theory, the distribution of prime ideals, class number formula, and class field theory.

MAS511 Algebra I

This course is designed to give the first year graduate students in mathematics a study of more advanced topics on groups, rings, modules, polynomials, Galois theory, commutative algebra, and multilinear algebra as a background for studying number theory and algebraic geometry. Topics include Sylow theory, the fundamental theorem of finitely generated abelian groups, free groups, commutative rings, localization, principal and factorial rings, Notherian rings, free modules, group rings, direct and inverse limits, and some advanced theory of ideals from the theory of rings and modules.

MAS512 Algebra II

This continuation of MAS511 is designed to give the first year graduate students in mathematics more advanced topics on groups, rings, modules, polynomials, Galois theory, commutative algebra, and multilinear algebra as background for studying number theory and algebraic geometry. Topics include a detailed approach to Galois theory and its applications, transcendental extensions and integral extensions of rings from field theory, simple and semisimple rings, and the representation theory of finite groups.

MAS513 Homological Algebra

Homological algebra is the branch of mathematics that studies chain complexes and derived functors. It is one of the most powerful tools in modern mathematics with applications to several mathematical subjects such as algebraic topology, algebraic geometry, commutative algebra, number theory, and representation theory. The aim of this course is to provide an introduction to the main tools of homological algebra.

MAS520 Differential Geometry

This is designed as a first-year graduate course, and it usually covers the concept of a differentiable manifold, the implicit function theorem, tangent spaces and tangent bundles, vector fields, differential forms, Stokes' theorem, tensors, and Lie groups.

MAS530 Differential Topology

The topics covered are usually manifolds and smooth maps, transversality and intersection theory, integration on manifolds, Morse theory, h-cobordism theory, and surgery theory.

MAS531 Algebraic Topology I

This is designed for a first-year graduate course, and it usually covers homology groups of a simplicial complex, topological invariance of the homology groups, relative homology and the Eilenberg-Steenrod axioms, singular homology, cohomology with various coefficients, and duality in manifolds.

MAS532 Algebraic Topology II

This course is a continuation of MAS531 and deals with more advanced topics, such as homology with coefficients, universal coefficient theorem, Kunneth formula, cohomology, cup product and cap product, orientation of manifolds, Poincare's duality theorem, signature of manifolds, higher homotopy groups, and higher homotopy theory.

MAS540 Real Analysis

In this course properties and applications of real variables functions are treated. Topics include measure theory, Lebesgue integrals, function spaces, basics of functional analysis, Radon measure and its applications, differential equations, and integral equations.

MAS541 Complex Function Theory

This course provides a treatment of functions of a complex variable. It also covers applicable complex analytic theories. Topics include Cauchy formulas, harmonic functions, the maximum modulus principle, Poisson formulas, approximation by rational functions, conformal mapping, zeros of analytic functions, analytic continuation, reflection principles, infinite products and series, entire functions, Riemann ζ-functions, Schwarz-Christoffel transform, Dirichlet problems, analytic continuations, and Hardy spaces.

MAS546 Wavelets and Applications

The basic theory of wavelets and their applications are treated. Fourier analysis, Wavelet transforms, Cardinal splines, wavelets and MRA, wavelet packets, and applications to signal analysis and image analysis.

MAS547 Approximation Theory

This course introduces the basics of approximation theory. Topics include polynomial approximation in various function spaces, interpolation, mechanical quadrature, approximation algorithms, error analysis. Continuous functions on a compact set are approximated by a system of some functions, and the asymptotic theory of the error is introduced.

MAS548 Symbolic Dynamics

This course studies spaces whose elements are strings of symbols, with applications to coding and information theory. Topics include shifts spaces, shift maps, sliding block codes, topological Markov chains, stochastic matrix theory, entropy, Markov partitions, topological conjugacy, and dimension groups.

MAS550 Probability Theory

Topics include the independence of events, conditional probability, martingale theory, stopping time, random walks, the law of large numbers, Markov chains, distribution and characteristic functions, the central limit theorem, and Gaussian processes. This course also treats advanced probability theory which is essential in applications.

MAS552 Queueing Theory with Applications

Stochastic processes and queueing theory for the analysis of telecommunication systems and manufacturing systems are treated. This course covers Poisson processes, renewal theory, discrete time and continuous time Markov chains, the M/G/1 queue and the G/M/1 queue, random walks, the GI/GI/1 queue, Brownian motion and its application to queueing systems, diffusion processes and stochastic order relations.

MAS555 Advanced Statistics

This course covers the theoretical background of statistical methods. Major topics of the course include basics of probability theory, characteristics of some probability distributions, laws of large numbers, central limit theorem, sufficiency, completeness, estimation, hypotheses testing, sequential analysis, analysis of variance, and non-parametric inference.

MAS556 Time Series Analysis

This course covers autocovariance and autocorrelation functions, stationary time series model, nonstationary time series model, mean square prediction, ARIMA prediction, updating prediction model identification, parameter estimation, spectral theory and estimation, and transfer function model.

MAS557 Theory and Application of Machine Learning

Machine Learning is concerned with computer programs that automatically improve their performance through experience. This course covers the theories and applications of machine learning in variety of perspectives. We cover topics such as decision trees, neural networks, Bayesian learning methods, evaluation of learning systems, computational learning theory, and genetic algorithms.

MAS560 Methods of Applied Mathematics

This course covers the mathematical theory of differential and integral equations. Fourier series theory and eigenvalue problems are introduced.

MAS565 Numerical Analysis

This course introduces computational linear algebra and finite differential methods. It also provides a basic foundation in numerical methods for scientific computation. Topics include matrix computation, Gaussian elimination, Choleski decomposition, LU decomposition, banded system block tridiagonal systems, the Gauss-Seidel method, the Jacobi method, block interaction, error analysis, interpolation theory, the approximation of functions, root-finding for nonlinear equations, numerical differentiation and integration, and stability.

MAS571 Stochastic Methods in Financial Mathematics

This course provides an introduction to the basics of financial mathematics. Topics include random walks, binomial trees, the Markov property, continuous-time stochastic processes, the Black-Scholes equation, partial differential equations, diffusion equations, initial value problems, Monte Carlo simulation, finite difference methods, martingales, and measures.

MAS575 Combinatorics

This course treats various concepts in combinatorics in detail. It covers enumeration, sieve methods, graphs, partially ordered sets, generating functions, and extreme problems.

MAS580 Recent Progress in Applied Mathematics

Special topics and/or recent progress in applied mathematics are introduced through this intensive course.

MAS581 Topics in Mathematics I

This course introduces mathematics trends or subjects that are not covered in any of the regular courses. Selected topics in current trends in mathematics will be treated.

MAS582 Topics in Mathematics II

This course introduces mathematics trends or subjects that are not covered in any of the regular courses. Selected topics in current trends in mathematics will be treated.

MAS583 Topics in Mathematics

This course introduces mathematics trends or subjects that are not covered in any of the regular courses. Selected topics in current trends in mathematics will be treated.

MAS611 Algebraic Geometry I

This course introduces the general ideas of algebraic geometry. Topics include curves, surfaces, varieties, sheaves, and divisors.

MAS612 Algebraic Geometry II

This course is a continuation of MAS611, introducing schemes, cohomology, and the Riemann-Roch theorem for curves and surfaces.

MAS613 Lie Algebra

This course introduces the theory of semisimple Lie algebras over an algebraically closed field of characteristic zero, with an emphasis on representations. Topics include Lie algebras, root systems and simple roots, the Weyl group, Cartan subalgebras, simple algebras, weight vector, the Weyl-Kostant-Steinberg formula, and admissible lattices.

MAS620 Lie Groups

This course introduces the theory of Lie groups. Topics include the basic concepts of Lie groups, differentiable manifolds, homogeneous space, Lie algebras, representations of Lie groups and Lie algebras, and structures of Lie groups.

MAS621 Riemannian Geometry

This is an introduction to basic concepts of Riemannian geometry. Topics include the definition of Riemannian manifolds, geodesics and curvature, the first and second variational formulas, Jacobi fields and conjugate points, comparison theorems, volume, and the Bishop-Gromov theorem.

MAS622 Symplectic Geometry

This course covers the basic concepts of linear symplectic geometry, symplectic manifold, and complex structure. Symplectic group action and various symplectic invariants are treated.

MAS623 Complex Geometry

This course introduces the basic concepts of complex manifold, Sheaf theory, and Hermitian complex geometry. It also covers Hodge decomposition theorem, Lefchetz decomposition theorem, and Kodaira embedding theorem.

MAS630 Geometric Topology

This class discusses fundamental results about 3-dimensional manifolds, including such topics as the Heegaard decomposition, the connected sum decomposition, Dehn's lemma, the sphere theorem, incompressible surfaces, Haken hierarchy, and the Seifert fibered and Jaco-Shalen-Johannson decompositions.

MAS631 Homotopy Theory

This course covers advanced topics in algebraic topology such as fibration and cofibration, H-spaces and co-H-spaces, the suspension theorem, the Hurwicz theorem, obstruction theory, homotopy operations, and spectral sequences.

MAS640 Harmonic Analysis

This course introduces Fourier series, Fourier integrals, and Fourier transforms. Topics include characters of locally compact abelian groups, Hardy space method, conjugate functions, maximal functions, the Hilbert transform method, and wavelet transform methods.

MAS641 Functional Analysis

Topics include Banach space, Hilbert space, linear operators defined on a vector space of functions, Hahn-Banach theorem, the Banach-Steinhaus theorem, Banach fixed point theorem, the open mapping theorem, Schauder theorem, solutions of differential and integral equations, differential calculus of operators and applications, spectral theory and applications, and variational methods.

MAS642 Generalized Functions

This course introduces basic properties of distributions and other generalized functions. Topics include locally convex vector spaces, distribution theory, generalized differentiation, integral transforms, Sobolev spaces, and applications to partial differential equations.

MAS645 Partial Differential Equations

This course introduces the modern theory of linear partial differential equations based on distribution theory. Topics include the classification of partial differential operators, hyper-ellipticity and local solvability of operators, the Cauchy problem for hyperbolic equations, boundary value problems for elliptic equations, Laplace, heat, and wave equations, and an introduction to the theory of pseudo differential operators.

MAS646 Nonlinear Differential Equations

This course introduces various nonlinear differential equations, their solutions and related theories, and their applications to engineering and sciences.

MAS647 Ordinary Differential Equations

This course introduces the basic theory of ordinary differential equations, including the existence and uniqueness of the solution of ordinary differential equations, the properties of autonomous system, the stability of solutions, the Lyapunov function, the properties of periodic solutions, and applications.

MAS650 Stochastic Differential Equations

Markov processes, Poisson processes, Brownian motions, Ito integrals, solutions of linear stochastic differential equations, and their asymptotic analysis, boundary value problems, filtering theory and applications to optimal control theory are treated.

MAS651 Stochastic Processes

General theory of stochastic processes and its applications are treated. This course covers Markov chains and processes, Gauss processes, diffusion processes, stationary processes, ergodic theory, spectral theory, and prediction theory.

MAS655 Graphic Models in Statistics

A statistical model from which we can represent the stochastic relationship among variables via a graph is called a graphical model. This model is easy to analyze with and draws much attention for its availability to the research fields of expert systems and artificial intelligence. Major topics include stochastic independence, independence graphs, information theory, the inverse of the variance-covariance matrix, the graphical Gauss model, the graphical log-linear model, the graph chain model, the mixed-variable model, and decomposition.

MAS656 Multivariate Statistical Analysis

This course covers statistical analysis methods for data with multiple random variables. Major topics of the course include multivariate normal distribution, properties of variance-covariance matrices of random vectors, distributions of sample variance- covariance matrices, T-square statistics, statistical classification, multivariate analysis of variance, independence of random vectors, testing hypotheses on variance-covariance matrices, principal component analysis, canonical correlation analysis, and factor analysis.

MAS657 Computational Models of Neural Networks

This course covers the models of biological and artificial neural networks in variety of perspectives. We cover topics such as models of neurons, neural coding, dynamics of neural networks, feed-forward neural networks, sample complexity, generalization bounds, optimization, and application to engineering problems.

MAS660 Numerical Fluid Mechanics
We study numerical methods for the Navier-Stokes equations. Numerical algorithms using the method of finite elements, and convergence tests and stability will be treated.

MAS661 Mathematical Fluid Mechanics
We study the mathematical foundations of Navier-Stokes equations and Euler equations. Especially we study the steady state theory for Stokes equations.

MAS665 Numerical Partial Differential Equations
This course provides a basic foundation in numerical methods for partial differential equations. The course introduces the methods for some model partial differential equations, then goes into more depth for each method as it applies to other types of equations. Topics include the concentrate finite difference method for initial-boundary value problems, the finite difference method for elliptic problems, the finite difference method for parabolic problems, the finite difference method for hyperbolic problems, stability, convergence, and applications.

MAS667 High Speed Computation
Parallel processing, multi-grid, domain decomposition for large scale computations are treated. We introduce parallel processing algorithms for super-computing.

MAS671 Computational Methods in Financial Mathematics
This course is an introduction to computational methods for the numerical simulations of financial market models. It emphasizes Monte Carlo and quasi-Monte Carlo methods, including pseudorandom numbers generations, reduction of variance, computational methods for option pricing, and data analysis of financial market.

MAS710 Representation Theory
This course introduces the representation theories of finite groups, Lie groups, and Lie algebras.

MAS711 Cryptology and Coding Theory
This course introduces second year graduate students to cry, coding, and data compression. Topics include entropy, Hoffman coding, DES, AES, RSA, discrete logarithms, Goppa code, and algebraic geometric codes.

MAS712 Algebraic Number Theory
Topics include extensions of Dedekind rings, L-functions, and class field theory.

MAS730 Knot Theory
This course studies knotting and linking phenomena of circles in a 3-dimensional space. More general embeddings of codimension 2 are also studied. The theories of knots, links, and braids are not only interesting enough by their own right, but they also are important to the understanding of low-dimensional manifolds, DNA folding, quantum physics, and related concepts. Various approaches are developed, typically including algebraic, geometric, and combinatorial methods. Topics covered by this course may vary depending on the offering.

MAS731 Transformation Group Theory
This course treats fundamental properties of topology of transformation groups, such as fixed point set and tube-slice, differential transformation groups and isotropy representations, bundle theory and G-vector bundle theory, G-simplicity complexes, and Smith theory.

MAS740 Ergodic Theory

This is a study of the basic structures of dynamical systems and families of systems, with applications to number theory, physics, geometry, and information theory. Topics include the Birkhoff ergodic theorem, mixing transformations, spectral properties, classification of measure-theoretic entropy, topological dynamics, invariant measures, topological entropy, and applications to number theory, physics, geometry and information theory.

MAS760 Mathematical Methods for Mechanics

We study basic mathematical theory for continuum mechanics. Frechet derivative, equilibrium point, Cauchy stress principle hyperelasticity, 3-dimensional elasticity and existence theory are introduced.

MAS765 Finite Element Method

This course studies the variation formula, the Ritz method, the Galerkin method, the finite element methods of elliptic equations, parabolic equations, and hyperbolic equations, analysis of the impact of the curvilinear boundary, analysis of error and convergence, and applications to engineering.

MAS771 Statistical Methods in Financial Mathematics

This course covers statistical methodologies that are useful for financial markets. Topics include volatility estimation, regression analysis, asset valuation model, estimation of yield curve, financial time series, risk management, term structure. Statistical softwares are treated as well.

MAS880 Topics in Mathematics

This course introduces mathematics trends or subjects that are not covered in any of the regular courses. Selected topics in current trends in mathematics will be treated.

MAS881 Topics in Mathematics I

This course introduces mathematics trends or subjects that are not covered in any of the regular courses. Selected topics in current trends in mathematics will be treated.

MAS882 Topics in Mathematics II

This course introduces mathematics trends or subjects that are not covered in any of the regular courses. Selected topics in current trends in mathematics will be treated.

MAS960 M.S. Thesis

MAS965 Independent Study in M.S.

Students choose topics and carry out research individually under the supervision of a chosen advisor.

MAS966 M.S. Seminar

MAS967 How to Teach Mathematics I (M.S.)

This course provides graduate students with strategies to effectively teach mathematics. Students will participate in teaching and discussion to help other students improve their teaching skills.

MAS968 How to Teach Mathematics II (M.S.)

This course is a continuation of MAS967 and provides graduate students with more strategies to effectively teach mathematics. Students will participate in teaching and discussion to help other students improve their teaching skills.

MAS980 Ph.D. Thesis

MAS986 Ph.D. Seminar

MAS987 How to Teach Mathematics I (Ph.D.)

This course provides graduate students with strategies to effectively teach mathematics. Students will participate in teaching and discussion to help other students improve their teaching skills.

MAS988 How to Teach Mathematics II (Ph.D.)

This course is a continuation of MAS987 and provides graduate students with more strategies to effectively teach mathematics. Students will participate in teaching and discussion to help other students improve their teaching skills.