Descriptions of Courses

❒ Undergraduate Program

MA210 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.

MA212 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.

MA241 Analysis I
This course provides sophomores in mathematics with a thorough background in mathematical analysis. Topics include real numbers, 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 of real numbers, and series.

MA242 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 series of functions, integration of series of functions, special functions, Gamma 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.

MA250 Probability and Statistics
This is an introduction to probability theory, probability distributions, the central limit theorem, tests of hypothesis, the analysis of variance, and regression. Course AM250 can take the place of MA250.

MA260 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.

MA270 Logic and Set Theory
This course introduces basic logic, the history of set theory, sets, classes, functions, relations, partially ordered sets, the axiom of choice, numbers, infinite sets, cardinal numbers, ordinal numbers, and similar topics.

MA271 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.

MA311 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.

MA312 Modern Algebra II
This course is a continuation of MA311 and deals with more advanced topics, such as Sylow theory, field extensions, Galois theory, and some basic notions of module theory.

MA321 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.

MA331 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.

MA341 Complex Variables
This rigorous treatment of the functions of a complex variable is a continuation of MA202 (Applied Analysis). Topics include the definition of analyticity, Cauchy's theorem, the maximum modules theorem, the residue theorem, the open mapping theorem, conformal mapping, the Riemann mapping theorem, and harmonic functions.

MA365 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. Topics include computing error analysis, algorithms, Gaussian elimination, Cholesky decomposition, error bounds, ill-conditioned problem, eigenvalues, Jacobi rotation and eigenvalue estimates, the power method, the OR algorithm, interpolation, and numerical integrations. This course can be replaced by taking AM321 instead.

MA370 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.

MA411 Introduction to Cryptography
This course introduces classical cryptosystems, symmetric cryptosystems, DES, AES, public key cryptosystems, digital signature, communication protocols, and information theory.

MA420 Analysis on Manifolds
This is an introduction to basic concepts of differentiable manifolds and differential forms. 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.

MA430 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.

MA440 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. AM432 can be taken instead of this course.

MA441 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, and the Lebesgue dominated convergence theorem.

MA450 Probability Theory and its Application
Topics include basic concepts and applications of probability theory, conditional probability, expectation, the law of large numbers, the central limit theorem, martingale theory, Markov chains, Brownian motion, and stationary random processes.

MA455 Mathematical Statistics
This is a mathematical treatment of statistics including such topics as random variables, distributions, average and variance, the law of large numbers, two-dimensional distributions, and decision making.

MA460 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.

MA465 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.

MA470 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.

MA471 Computational Mathematics of Financial Derivatives
This course introduces mathematical models for various financial derivatives. It also deals with computations and their numerical solutions.

MA480 Topics in Mathematics
This course presents some topics which are not incorporated into regular courses.

MA490 Research in Mathematics
Seniors in their final semester do research projects under the direction of their undergraduate advisors.

MA495 Individual Study
This is a special course which can be designed by students. Interested students should consult a professor and hand in a proposal.
MA496 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 Course

MA500 Applied Algebra
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.

MA501 Applied Real and Complex Analysis
This course introduces measure theory and the Lebesgue integral, together with their applications to probability and differential and integral equations. It also introduces the basics of functional analysis, residue theorem, conformal mapping, special functions, and approximation methods.

MA510 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.

MA511 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.

MA512 Algebra II
This continuation of MA511 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.

MA513 Combinatorics
This course treats various concepts in combinatorics in detail. It covers enumeration, sieve methods, graphs, partially ordered sets, generating functions, and extreme problems.

MA520 Differential Geometry I
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.

MA521 Differential Geometry II
This is a continuation of MA520. Topics include Lie groups and Lie algebras, homogeneous spaces, vector bundles, fiber bundles and connection, Riemannian manifolds, and curvature.
MA530 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.

MA531 Algebraic Topology I
This is designed for a first-year graduate course and 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.

MA532 Algebraic Topology II
This course is a continuation of MA531.

MA540 Real Analysis

Topics include measure theory, Lebesgue integrals, function spaces, differential equations, and integral equations. This course or AM541 can be taken.

MA541 Complex Function Theory

This course provides a treatment of functions of a complex variable, including harmonic functions, the maximum modulus principle, approximation by rational functions, conformal mapping, zeros of analytic functions, analytic continuation, and Hardy spaces. This course can be replaced with AM542.

MA551 Applied Probability

This course introduces basic concepts in probability theory, including Poisson processes, renewal processes, Markov chains, semi-Markov processes, and queueing theory. This course can be replaced with AM551.

MA565 Numerical Analysis

This course introduces computational linear algebra and finite differential methods. 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, and stability. This course can be replaced with AM520.

MA567 Approximation Theory

This course introduces the basics of approximation theory. Continuous functions on a compact set are approximated by a system of some functions, and the asymptotic theory of the error is introduced.

MA568 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.

MA569 Stochastic Analysis in Financial Market Models

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.

MA611 Algebraic Geometry I

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

MA612 Algebraic Geometry II

This course is a continuation of MA611, introducing schemes, cohomology, and the Riemann-Roch theorem for curves and surfaces.

MA613 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.

MA620 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.

MA621 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.

MA630 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.

MA631 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.

MA640 Harmonic Analysis
This course introduces Fourier series and Fourier transforms, including characters of locally compact abelian groups. This course can be replaced with AM643.

MA641 Functional Analysis
Topics include linear operators defined on a vector space of functions, The Hahn-Banach theorem, the Banach-Steinhaus theorem, the open mapping theorem, solutions of differential and integral equations, and spectral theory. This course can be replaced with AM641.

MA643 Theory of Generalized Functions
Topics include locally convex vector spaces, distribution theory, generalized differentiation, and applications to partial differential equations. This course can be replaced with AM644.

MA650 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.

MA665 Numerical Analysis of Partial Differential Equations
This course introduces the concentrate finite difference method for initial-boundary value problems. Topics include 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. This course can be replaced with AM620.

MA710 Representation Theory
This course introduces the representation theories of finite groups, Lie groups, and Lie algebras.

MA711 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.

MA712 Algebraic Number Theory
Topics include extensions of Dedekind rings, L-functions, and class field theory.

MA730 Knot Theory
This course studies knotting and linking phenomena of circles in a 3-dimensional space. More general embeddings of codimension2 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.

MA731 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.

MA740 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.

MA741 Advanced Complex Function Theory
This course covers fundamental notions and results in the function theory of several complex variables. Topics include integral representations of holomorphic functions, balls and polydisks, the domain of convergence, the domain of holomorphy, holomorphic and polynomial hulls, pseudoconvex domains, pluriharmonic functions, plurisubharmonic functions, Harmander's solution, the Levy problem, tangential Cauchy-Riemann equations, analytic varieties, biholomorphic maps, proper holomorphic maps, automorphisms, peak sets, and interpolation sets.

MA743 Theory of 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, and an introduction to the theory of pseudo differential operators.

MA744 Nonlinear Differential Equations
This course introduces various nonlinear differential equations, their solutions and related theories, and their applications to engineering and sciences.

MA745 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.

MA750 Theory of Stochastic Processes
This course introduces Markov chains and processes, Gauss processes, diffusion processes, stationary processes, ergodic theory, spectral theory, and prediction theory.

MA765 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.

MA880 Topics in Mathematics
This course introduces mathematics trends or subjects that are not covered in any of the regular courses.

MA960 M.S. Thesis

MA965 Independent Study in M.S.

MA966 M.S. Seminar

MA967 M.S. Thesis Seminar

MA980 Ph.D. Thesis

MA986 Ph.D. Seminar

MA987 Ph.D. Thesis Seminar