

Jiaxuan Chen

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TRANSCRIPT OF MATHEMATICS COURSEWORK Fall 2026 - Spring 2027

Department of Mathematics, Krieger School of Arts and Sciences, Johns Hopkins University

AS110.376 – The Mathematics of Cryptography and Cybersecurity, Lauren Ross, Spring 2027.

The Mathematics of Cryptography and Cybersecurity introduces students to the mathematical principles that secure digital communication in the modern world. The course focuses on the theory and construction of public-key cryptosystems and digital signature schemes, emphasizing the number-theoretic foundations of data security. Students will explore how mathematical ideas such as modular arithmetic, prime factorization, and discrete logarithms underpin real-world cybersecurity protocols including RSA, Diffie–Hellman key exchange, and elliptic curve cryptography.

In addition to classical and modern cryptographic systems, the course highlights the role of mathematics in assessing vulnerabilities, analyzing security guarantees, and understanding emerging cryptographic challenges in cybersecurity. Topics include primality testing, factorization algorithms, probability and information theory, and collision resistance. This course offers a rigorous yet accessible path for students in mathematics and computer science to understand how abstract theory translates into the protection of information in a digital age.

Textbook: An Introduction to Mathematical Cryptography, by Hoffstein, Pipher, and Silverman. ISBN-13: 978-1441926746

Grade: TBD

AS 110.436 – Introduction to Algebraic Topology, Nicholas Marshburn, Fall 2026.

This course introduces the central ideas and tools of algebraic topology, with an emphasis on exposure rather than technical depth. Students will learn how algebraic structures such as chain complexes, homology, and cohomology can be used to study and distinguish topological spaces. Key topics include simplicial complexes, the Snake Lemma, the Universal Coefficient Theorem, and the Künneth Theorem, with a focus on concrete examples and computations. The course also explores broader frameworks such as the Eilenberg–Steenrod axioms and CW complexes, along with cellular (co)homology. Time permitting, students will encounter spectral sequences and their applications. By the end of the course, students will have a working familiarity with the main concepts and techniques of algebraic topology, preparing them for further study in topology and related fields.

Textbook: Hatcher, *Algebraic Topology*

Grade: TBD

AS 110.436 – Honors Algebra II, Nicholas Marshburn, Fall 2026.

This is a continuation of Algebra I. Topics include: principal ideal domains, structure of finitely generated modules; introduction to field theory, linear algebra over a field, and Field extensions; splitting field of a polynomial, algebraic closure of a field; Galois theory: correspondence between subgroups and subfields. Solvability of polynomial equations by radicals.

Textbook: Dummit & Foote, Abstract Algebra

Grade: TBD

AS 110.413 – Analysis II, Lauren Ross, Fall 2026.

This course continues AS.110.405 with an emphasis on the fundamental notions of modern analysis. Sequences and series of functions, Fourier series, equicontinuity and the Arzela-Ascoli theorem, the Stone-Weierstrass theorem, functions of several variables, the inverse and implicit function theorems,

introduction to the Lebesgue integral.

Textbook: Way of Analysis, Jones & Bart, ISBN: 9780763714970

Grade: TBD

AS 110.435 – Introduction to Algebraic Geometry, Nicholas Marshburn, Spring 2026.

Algebraic geometry studies zeros of polynomials in several variables and is based on the use of abstract algebraic techniques, mainly from commutative algebra, for solving geometric problems about these sets of zeros. The fundamental objects of study are algebraic varieties which are the geometric manifestations of solutions of systems of polynomial equations. Algebraic geometry occupies a central place in modern mathematics and has multiple conceptual connections with diverse fields such as complex analysis, topology and number theory. This course aims to provide to an undergraduate student majoring in mathematics the fundamental background to approach the study of algebraic geometry by providing the needed abstract knowledge also complemented by several examples and applications.

Textbook: C. Ciliberto, *An Undergraduate Primer in Algebraic Geometry*

Grade: A+

AS 110.413 – Introduction to Topology, Lauren Ross, Spring 2026.

Topological spaces, connectedness, compactness, quotient spaces, metric spaces, function spaces. An introduction to algebraic topology including covering spaces, the fundamental group, and other topics are covered as time permits.

Textbook: J. Munkres, *Topology: a first course*

Grade: A+

Department of Mathematics, North Carolina State University

MA 755 – Riemannian Geometry, Teemu Saksala, Fall 2026.

An introduction to smooth manifolds with metric. Topics include: Riemannian metric and generalizations, connections, covariant derivatives, parallel translation, Riemannian [or Levi-Civita] connection, geodesics and distance, curvature tensor, Bianchi identities, Ricci and scalar curvatures, isometric embeddings, Riemannian submanifolds, hypersurfaces, Gauss Bonnet Theorem; applications and connections to other fields.

Textbook: J. Lee, *Introduction to Riemannian Manifolds*

Grade: TBD

MA 513 – Introduction to Complex Variables, Bevin Maulsby, Fall 2026.

Complex analysis is an amazing subject which is fundamental to most areas of mathematics, and has numerous applications to science and engineering. While there are many similarities with the calculus of real functions (e.g. we will learn to differentiate and integrate complex-valued functions similar to calculus), the behavior of complex functions is very different. For example, we will prove the Fundamental Theorem of Algebra which states that all non-constant polynomials have a complex root. We will prove Liouville's Theorem, which states that a bounded differentiable function on the complex plane is constant. After setting up much of the theory of differentiation and integration of complex functions, we will be able to solve difficult real-valued problems using complex functions. We will also study some connections between complex functions and other realms of mathematics, such as geometry and number theory. The style will be a balance of abstract proof-based arguments and hands-on computations.

Textbook: Agarwal, Ravi P., *An introduction to Complex Analysis*

Grade: TBD

MA 523 – Linear Transformations and Matrix Theory, Summer 2026, Bevin Maulsby.

Vector spaces, linear transformations and matrices, orthogonality, orthogonal transformations with emphasis on rotations and reflections, matrix norms, projectors, least squares, generalized inverses, definite matrices, singular values.

Textbook: Lecture notes

Grade: A

University of Illinois at Urbana-Champaign

MATH 442 – Partial Differential Equations, Fall 2026, Kay Kirkpatrick.

This course introduces students to partial differential equations, emphasizing the wave, diffusion and Laplace equations. The focus is on understanding the physical meaning and mathematical properties of solutions of partial differential equations. Methods include fundamental solutions and transform methods for problems on the line, and separation of variables using orthogonal series for problems in regions with boundary. Convergence of Fourier series is covered in detail.

Final Project: Geometric PDEs

Textbook: Walter A. Strauss, Partial Differential Equations: An Introduction, John Wiley & Sons, 2008 (2nd ed.).

Grade: TBD

MATH 447 – Real Variables, Fall 2026, Jason Elliot.

Careful development of elementary real analysis for those who intend to take graduate courses in Mathematics. Topics include completeness property of the real number system; basic topological properties of n -dimensional space; convergence of numerical sequences and series of functions; properties of continuous functions; and basic theorems concerning differentiation and Riemann integration.

Textbook: Ross, Elementary Analysis

Grade: TBD

MATH 423 – Differential Geometry, Spring 2026, Jennifer Lansing.

This course covers applications of the calculus to the study of the shape and curvature of curves and surfaces; introduction to vector fields, differential forms on Euclidean spaces, and the method of moving frames for low-dimensional differential geometry.

Textbook: Barrett O'Neill. (2006). Elementary Differential Geometry (2nd Edition). Academic Press (Elsevier).

Grade: A

Stony Brook University

MAT 487 – Independent Study in Special Topics: Analytic Number Theory, Fall 2026, Robert Hough.

A reading course for juniors and seniors. The topics may be chosen by the student with the approval of a supervising member of the faculty, who also takes responsibility for evaluation. A topic that is covered in a course regularly offered by the department is not appropriate for independent study.

Textbook: Apostol, Introduction to Analytic Number Theory

Grade: TBD

CSE 645 – Seminar in Languages, Fall 2026, Annie Liu, CR Ramakrishnan, Michael Kifer, David Warren, Paul Fodor..

We will read papers and discuss research ranging from high-level specifications (such as logic, rules, and

sets) to algorithms and methods for efficient implementations of programming languages, with a wide range of applications.

Final Project: Presentation: Bridge of Formal Languages and Automata

Grade: TBD

AMS 335 – Game Theory, Summer 2026, .

Game theory studies strategic interaction among decision makers. This course introduces the main equilibrium concepts for non-cooperative games in both static and dynamic settings with complete information. Topics include iterated strict dominance, rationalizability, Nash equilibrium, backward induction, and subgame perfection. Applications will be drawn from economics, politics, bargaining, repeated games, market competition, advertising, finance, labor markets, and sports.

Textbook: Tadelis, Game Theory

Grade: B

AMS545 – Computational Geometry, Spring 2026, Joseph S.B. Mitchell.

Study of the fundamental algorithmic problems associated with geometric computations, including convex hulls, Voronoi diagrams, triangulation, intersection, range queries, visibility, arrangements, and motion planning for robotics. Algorithmic methods include plane sweep, incremental insertion, randomization, divide-and-conquer, etc. This course is offered as both AMS 545 and CSE 555.

Final Project: Discrete geometric evolution flows

Textbook: Computational Geometry: Algorithms and Applications (3rd Edition), by de Berg, Cheong, van Kreveld, and Overmars

Grade: A-

PHIL 108 – Logical and Critical Reasoning, Winter 2026, .

The course is designed to introduce and familiarize students with the skill of recognizing, analyzing, and constructing arguments. This will be done through the critical thinking approaches of formal and informal logic(s). We will inquire into what constitutes an argument, how we justify arguments, what makes evidence relevant, how to evaluate arguments, and other related questions. This course is asynchronous, thus there is no lecture component. While students will be expected to do the reading on their own, I will provide slides which should serve to supplement their reading.

Textbook: Logic (3rd edition) by Stan Baronett.

Grade: A

Fields Academy, Fields Institute, University of Toronto

Fields Academy Shared Graduate Course – Advanced Topics in Geometric Topology, Spring 2027, Ian Hambleton, McMaster University.

Morse theory, cobordism, classification of manifolds; introduction to Yang-Mills gauge theory (PDE on smooth 4-manifolds), applications to smooth vs topological structures on 4-manifolds, finite group actions.

Textbook: Bott, Raoul; Tu, Loring W. "Differential forms in algebraic topology". Graduate Texts in Mathematics, 82. Springer-Verlag.

Grade: TBD

MATH 9310 – Introduction to Complex Manifolds, Rasul Shafikov, Western University of Ontario, Fall 2026.

Complex manifolds form a rich class of manifolds that connects complex analysis, differential geometry, algebraic topology, algebraic geometry, PDEs, and other branches of mathematics together. Complex

manifolds have many deep applications not only in mathematics but also in physics. It is currently one of the most actively developed areas of pure mathematics that offers many open unsolved problems. The goal of the course is to give a gentle introduction to complex manifolds, emphasizing the underlying concepts, basic geometric constructions, and outlining several fundamental results. The intent is to cover both Stein and projective manifolds, including the Kodaira embedding theorem. The course evaluation will be based on homework assignments. A tentative list of topics to be covered: Holomorphic functions and maps; Examples of complex manifolds: projective spaces, affine and projective manifolds, tori, complex submanifolds, Stein manifolds, and more. Holomorphic vector bundles; divisors and line bundles; Differential calculus and the Dolbeault complex; Sheaves and sheaf cohomology; Kähler manifolds; Hodge theory and the Kodaira embedding theorem.

Textbook: J. Lee, Introduction to Complex Manifolds

Grade: TBD

Fields Academy Shared Graduate Course – Elements of Mathematical Formalization and Auto-Formalization with Lean, Arul Shankar, University of Toronto & Kevin Wilson, Borealis AI, Fall 2026.

Since computers have been available, mathematicians have used them both to develop complex conjectures such as Birch and Swinnerton-Dyer and to prove mathematical statements such as the Four Colour Theorem. Recently, advances in artificial intelligence have pushed computers' capabilities to new heights, with several groups announcing achievements such as automatically providing answers to IMO problems, formalizing deep theorems like the Strong Prime Number Theorem, and making substantial progress on heretofore unproved lemmas in research mathematics. In this course, we'll cover some of the key components that have pushed this revolution forward. The course is divided into two parts. First, we will cover formalization: how mathematicians use the Lean interactive theorem prover to check that a proof is correct. Second, we'll explore how modern AI tools are being used to "automate" parts of the workflow of mathematics, with a focus on using agentic workflows to formalize mathematics..

Textbook: None

Grade: TBD

Department of Mathematics, Utrecht University

Utrecht Summer School – Geometry, Álvaro del Pino Gómez and Wilfred de Graaf., Summer 2026.

Each day of the school aims to cover a different facet of modern Geometry. Topics covered in previous years include: Algebraic Geometry, Arithmetic Geometry, Differential Topology, Algebraic Topology, Symplectic Geometry, Complex Geometry, Number Theory, Lie Theory, Logic, History of Geometry, and applications to Physics.

Textbook: None

Grade: Pass

Department of Mathematics, University of Alberta

MATH 497 – Topics in Convex Geometry, Vladyslav Yaskin, Summer 2026.

This reading course provides an introduction to convex geometry through a guided study of the textbook Lectures on Convex Geometry by Daniel Hug and Wolfgang Weil. The course focuses on fundamental concepts and methods in the geometry of convex bodies, including mixed volumes, area measures, and integral-geometric techniques.

Textbook: D. Hug and W. Weil, Lectures on Convex Geometry

Grade: A

Department of Mathematics, University of North Dakota

MATH 442 – Linear Algebra, Bryce Alan Christopherson, Spring 2026.

In this class, we will cover the following: A theoretical treatment of finite-dimensional vector spaces, linear maps, eigenvalues and eigenvectors, inner product spaces, operators on inner product spaces, operators on real and complex vector spaces, traces, and the determinant.

Textbook: Axler, Linear Algebra Done Right

Grade: A

Department of Mathematics, Indiana University East

MATH-M384 – Logic, Saleh Aliyari, Fall 2026.

This course is a first course in mathematical logic for undergraduates. Topics include a study of sentential logic and first-order logic. The main goal in this course is to derive the Soundness and the Completeness Theorems in first-order logic and some of their consequences.

Textbook: Enderton, A Mathematical Introduction to Logic

Grade: TBD

MATH-M403 – Introduction to Modern Algebra I, Jack Barlow, Summer 2026.

Study of groups, rings, fields (usually including Galois theory), with applications to linear transformations.

Textbook: John B. Fraleigh & Neal Brand, A First Course in Abstract Algebra. 8th Edition 2020.

Grade: C

MATH-M340 – Graph Theory, Hannah Klawns, Summer 2026.

Introduction to graph theory with applications. Topics include directed and undirected graphs, paths, cycles, trees, spanning trees, Eulerian graphs, Hamiltonian graphs, connectivity, network flow, planar graphs, and coloring.

Textbook: Geir Agnarsson and Raymond Greenlaw, Graph Theory: Modeling, Applications & Algorithms, 1st Edition (2007) Pearson.

Grade: B

MAGIC, UK Online Graduate Course Network

MAGIC009 – Category Theory, Robert Laugwitz, University of Nottingham, Fall 2026.

Fundamental notions and results of category theory, including categories, functors, natural transformations, limits, colimits, duality, equivalences of categories, adjunctions, presheaves, and the Yoneda lemma. The course emphasizes the calculus of functors and natural transformations and categorical reasoning.

Grade: TBD

MAGIC020 – Dynamical Systems, Peter Ashwin, University of Exeter, Fall 2026.

Graduate-level introduction to the qualitative theory of dynamical systems, including asymptotic behavior of ODEs, stability, phase-space analysis, periodic orbits, the Poincaré–Bendixson theorem, bifurcation theory, normal forms, centre manifolds, Hopf bifurcation, chaotic systems, horseshoes, period doubling, symbolic dynamics, and Sharkovskii’s theorem.

Textbook: G. Teschl, Ordinary Differential Equations and Dynamical Systems; P. Glendinning, Stability, Instability and Chaos; R. L. Devaney, An Introduction to Chaotic Dynamical Systems; S. H. Strogatz, Nonlinear Dynamics and Chaos; M. Viana and J. M. Espinar, Differential Equations: A Dynamical Systems Approach to Theory and Practice

Grade: TBD

Stanford University Online High School& University-Level Online

UM 180 – Mathematical Discovery and Problem Solving Seminar, Dana Paquin, Fall 2026.

In this semester-long seminar, we will explore, discover, and prove results across a wide range of mathematical fields, with an emphasis on the process of mathematical discovery itself. Rather than working through a single subject in a linear fashion, we will investigate a sequence of rich problems, each chosen because it can be approached in genuinely different ways, and each serving as a doorway into a substantial area of mathematics. Along the way we will develop and use tools from number theory, combinatorics, algebra, geometry, and analysis, and we will see repeatedly how techniques developed in one area can illuminate questions in another. A central theme of the course is that a good problem rarely has just one solution. We will begin by examining a deceptively simple statement about tilings of rectangles and proving it in many genuinely different ways—some requiring no background at all, and others drawing on tools such as parity arguments, generating functions, and quadratic residues. From there we will take up the infinitude of the primes, sums of two squares, Pascal’s triangle and its many identities, and a range of other topics, culminating in questions that remain open areas of current mathematical research. You may find this course to be very different from your previous mathematics courses. Instead of memorizing formulas and procedures, we will spend our time investigating and exploring patterns, forming conjectures from data, and discovering why and how mathematical statements are true. We will, in general, be less focused on “getting an answer” and more focused on understanding and explaining why our answer is valid, and how it might extend to more advanced situations. In constructing proofs of our results, there will be a significant amount of writing in this course. This course represents a capstone experience in both the breadth and depth of your study of mathematics.

Textbook: Course notes

Grade: A

XM521 – Multivariable Differential Calculus, Leonardo De Assis, Fall 2025.

Differential calculus for functions of two or more variables, including vectors and vector-valued functions, tangent and normal vectors, curvature, partial derivatives, differentiability, directional derivatives and gradients, maxima and minima, and optimization using Lagrange multipliers.

Textbook: Calculus: A New Horizon, H. Anton, I. Bivens, and S. Davis, 6th edition or later

Grade: A

XM522 – Multivariable Integral Calculus, Leonardo De Assis, Spring 2026.

Integral calculus for functions of two or more variables, including double and triple integrals, change of variables and the Jacobian, vector fields, line integrals, independence of path, Green’s theorem, the divergence theorem, and Stokes’ theorem.

Textbook: Calculus: A New Horizon, H. Anton, I. Bivens, and S. Davis, 6th edition or later

Grade: A

XM511 – Linear Algebra, Margarita Kanarsky, Fall 2025.

Introduction to linear algebra, including matrices, linear equations, vector spaces, bases, coordinates, linear transformations, eigenvectors, eigenvalues, and diagonalization.

Textbook: Linear Algebra, R. Bronson and G. Costa

Grade: A

XM531 – Differential Equations, Matt Plante, Fall 2026.

Techniques and methods for solving ordinary differential equations, including linear, separable, and exact equations, existence and uniqueness theorems, higher-order equations, variation of parameters, undetermined coefficients, series solutions, Laplace transforms, and systems of equations.

Textbook: Elementary Differential Equations and Boundary Value Problems, W. Boyce and R. DiPrima, 6th edition or later

Grade: TBD

XM452 – Number Theory, Matt Plante, Spring 2026.

Introduction to number theory, including Euclid's algorithm, divisibility, prime numbers, congruences, Fermat's, Euler's, Wilson's, and Lagrange's theorems, quadratic residues, continued fractions, Diophantine equations, quadratic fields, and quadratic integers.

Textbook: An Introduction to Number Theory, H. Stark

Grade: A-

IM 160 – Discrete Mathematics, Dana Paquin, Fall 2026.

Introduction to discrete mathematics, including enumerative combinatorics, partitions, generating functions, inclusion-exclusion, recurrence relations, Ramsey theory, introductory graph theory, mathematical reasoning, conjecture formulation, and rigorous proof-writing techniques.

Textbook: Discrete Mathematics: An Open Introduction, O. Levin

Grade: A

Advanced Placemnet

AP Calculus BC College Board Spring 2026 Grade: 5

Notes

This file includes taken courses fall 2025 - spring 2026, and course under progress for fall 2026, and course planned for spring 2027.