

Number Theory

Dates: Jan–May, 2017 Course Number: MATH 367 School: University of San Francisco

Grade: A- (A-E/F) Credit: 3 Instructor: Dr. Paul Zeitz

Textbooks: James E. Pommershem, Tim K. Marks, and Erica L. Flapan, *Number Theory*, 2010 Wiley.

Topics: Numbers, rational and irrational, mathematical induction, divisibility and primes, the Euclidean algorithm, linear Diophantine equations, the fundamental theorem of arithmetic, modular arithmetic, modular number systems, exponents modulo n , primitive roots, quadratic residues, primality testing, and Gaussian integers.

Modern Algebra I

Dates: Jan–May, 2019 Course Number: MATH 335 School: San Francisco State University

Grade: A (A-E/F) Credit: 3 Instructor: Dr. Joseph Gubeladze

Textbooks: C. C. Pinter, *A Book of Abstract Algebra, Second Edition*, 1990 McGraw-Hill.

Topics: 1. Groups: Definition and basic properties of groups. Special emphasis on symmetric groups to emphasize the non-abelian structure. Subgroups. Cyclic groups. Homomorphisms, isomorphisms, and normal subgroups. Left and right cosets, Lagrange's theorem, factor/quotient groups, isomorphism theorems. The statement of the Fundamental Theorem of Finitely Generated Abelian Groups and applications. 2. Rings: Definition of rings, unit, zero-divisor, division ring, integral domain, field; basic properties. Ring homomorphisms and isomorphisms, subrings, images and kernels, definition of ideals and quotient rings, one- and two-sided ideals, isomorphism theorems, properties of ideals. PIDs, greatest common divisor. UFDs, division algorithm, irreducibility of polynomials.

Modern Algebra II

Dates: Sept–Dec, 2019 Course Number: MATH 735 School: San Francisco State University

Grade: B+ (A-E/F) Credit: 3 Instructor: Dr. Joseph Gubeladze

Textbooks: John Stillwell, *Elements of Algebra*, 2000 Springer.

Topics: 1. Groups: Quick review of fundamentals of group theory emphasizing quotient groups. Definition of group actions and examples, orbits, conjugation action, conjugacy class, conjugacy classes in the symmetric group. The statement of Sylow's Theorem and its simple applications. 2. Modules and Vector Spaces: Definition of modules, abelian groups as \mathbb{Z} -modules, vector spaces as F -modules, vector spaces with linear transformations as $F[x]$ -modules, submodules module homomorphisms, quotient modules, isomorphism theorems, direct sums, free modules. The statement of the main theorem of finitely generated modules over PIDs. 3. Fields and Field Extensions: Maximal and prime ideals. Characteristic of a field, field extension, degree of an extension, computing in a finite extension, algebraic extension, minimal polynomial, roots of unity. Splitting fields. Finite fields. 4. Miscellaneous topics: Galois theory.

Independent Study

Dates: Sept–Dec, 2019 Course Number: MATH 899 School: San Francisco State University

Grade: A- (A-E/F) Credit: 3 Instructor: Dr. Joseph Gubeladze

Textbooks: Joseph Gubeladze, *Polytopes, Rings, and K-theory*, 2000 Springer.

Topics: Polyhedra and their faces, finite generation of cones, finite generation of polyhedra, polyhedral complexes, subdivisions and triangulations, regular subdivisions, rationality and integrality.

Real Analysis

Dates: Jan–May, 2017 Course Number: MATH 453 School: University of San Francisco
 Grade: A Credit: 3 Instructor: Dr. Stephen Devlin
 Textbooks: Stephen Abbott, *Understanding Analysis*, 2015 Springer.
 Topics: the axiom of completeness, sequences and series, topology of the real line, limits and continuity, the real number system, the derivative and Riemann integral.

Analytic Number Theory

Dates: Jan–May, 2018 Course Number: MATH 398 School: University of San Francisco
 Grade: A Credit: 3 Instructor: Dr. Paul Zeitz
 Textbooks: G. J. O. Jameson, *The Prime Number Theorem*, 2003 Cambridge University Press, G. Tenenbaum and M. M. France *The Prime Numbers and their Distribution*, 2003 Cambridge University Press, and Lars V Ahlfors, *Complex Analysis*, 1979 McGraw-Hill.
 Topics: Counting prime numbers, arithmetic functions, Abel summation, estimation of sums by integers, Euler’s summation formula, the function $\text{li}(x)$, Chebyshev’s theta function, Dirichlet series and the zeta function, Euler product, Möbius function, the series for $\log \zeta(s)$ and $\zeta'(s)/\zeta(s)$, Chebyshev’s psi function and powers of primes, estimates of some summation functions, extension of the definition of the zeta function, inversion of Dirichlet series, the integral version of the fundamental theorem, an alternative method; Newman’s proof, the limit and series versions of the fundamental theorem, the prime number theorem, error estimates and the Riemann hypothesis.

Introduction to Complex Analysis

Dates: Jan–May, 2019 Course Number: MATH 380 School: San Francisco State University
 Grade: A (A-E/F) Credit: 3 Instructor: Dr. Chun-Kit Lai
 Textbooks: Brown and Churchill, *Complex Variable and Applications*, 6th Edition, 1995 McGraw-Hill.
 Topics: The Field of Complex Numbers. Analytic Functions: properties of analytic functions, Cauchy-Riemann equations. Elementary Functions: algebraic, trigonometric and logarithmic functions. Contour Integrals of Complex Functions: Cauchy’s Theorem, Cauchy’s Integral Formula, Cauchy’s Inequalities, Liouville’s Theorem, Morera’s Theorem, Maximum Modulus Theorem and elementary properties of harmonic functions. Complex Series: power series, Taylor’s Theorem, Laurent’s Theorem and Laurent series, residues. Conformal mapping with applications chosen from: Dirichlet and Neumann problems, heat conduction, fluid flow and electric potential.

Real Analysis I

Dates: Sept–Dec, 2019 Course Number: MATH 370 School: San Francisco State University
 Grade: A (A-E/F) Credit: 3 Instructor: Dr. Chun-Kit Lai
 Textbooks: William Wade, *An Introduction to Analysis*, 3rd Edition, 2003 Prentice Hall.
 Topics: The Real Number System: ordered field axioms, the Well-Ordering Principle, the Completeness Axiom, countability. Sequences in \mathbb{R} : limit theorems, Bolzano-Weierstrass Theorem, Cauchy sequences. Continuity on \mathbb{R} : two and one-sided limits of functions, limits of functions at infinity, continuity, uniform continuity. Differentiability on \mathbb{R} : the derivative, differentiability theorems, the Mean Value Theorem, L’Hospital’s Rule, monotone functions, the Inverse Function Theorem. The Riemann integral: Riemann sums, The Fundamental Theorem of Calculus.

Real Analysis II: Several Variables

Dates: Jan–May, 2020 Course Number: MATH 770 School: San Francisco State University
 Grade: A (A-E/F) Credit: 3 Instructor: Dr. Alex Schuster
 Textbooks: William Wade, *An Introduction to Analysis*, 3rd Edition, 2003 Prentice Hall.
 Topics: Infinite sequences and series of functions, uniform convergence. Introduction to metric spaces, Heine-Borel Theorem. Differentiable maps between Euclidean spaces; Derivative matrix, Chain Rule, Mean-Value Theorem. Inverse Function Theorem.

Theory of Functions of a Complex Variable

Dates: Jan–May, 2020 Course Number: MATH 730 School: San Francisco State University

Grade: B+ (A-E/F) Credit: 3

Instructor: Dr. Chun-Kit Lai

Textbooks: E. M. Stein and R. Shakarchi, *Princeton Lectures in Analysis: Complex Analysis*, 2003 Princeton University Press.

Topics: holomorphic functions, Schwarz reflection principle, complex integration, Cauchy's theorem and its consequences, harmonic functions, sequences and series of analytic functions, isolated singularities, open mapping theorem, conformal mapping, the Dirichlet problem in a strip, Schwarz lemma, automorphisms of the disc and upper half-plane, Riemann mapping theorem, and Montel's theorem.

Measure & Integration

Dates: Jan–May, 2020 Course Number: MATH 710 School: San Francisco State University

Grade: B+ (A-E/F) Credit: 3

Instructor: Dr. Sheldon Axler

Textbooks: Sheldon Axler, *Measure, Integration & Real Analysis*, 2020 Springer.

Topics: Infinite sequences and series of functions, uniform convergence. Introduction to metric spaces, Heine-Borel Theorem. Differentiable maps between Euclidean spaces; Derivative matrix, Chain Rule, Mean-Value Theorem. Inverse Function Theorem.

Advanced Linear Algebra

Dates: Sept–Dec, 2020 Course Number: MATH 725 School: San Francisco State University

Grade: B+ (A-E/F) Credit: 3

Instructor: Dr. Henry Boateng

Textbooks: Sheldon Axler, *Linear Algebra Done Right*, 2015 Springer.

Topics: Vector spaces, linear independence, bases, dimension. Linear maps, null space, range, matrix representations, invertibility. Invariant subspaces, upper triangular matrix representations, eigenvectors and eigenvalues. Inner products, norms, orthonormal bases, Gram Schmidt process, orthogonal projection and best approximation, linear functionals and adjoints, Riesz representation. Self-adjoint and normal operators, the Spectral Theorem, positive operators, isometries, polar and singular-value decompositions. Generalized eigenvalues, characteristic and minimal polynomials, nilpotent operators, Jordan canonical form.

Functional Analysis

Dates: Jan–May, 2021 Course Number: MATH 711 School: San Francisco State University

Grade: B+ (A-E/F) Credit: 3

Instructor: Dr. Sheldon Axler

Textbooks: Sheldon Axler, *Measure, Integration & Real Analysis*, 2021 Springer.

Topics: Metric spaces, Baire Category Theorem. Banach and Hilbert spaces, classical examples. Bounded operators and dual spaces. Hahn-Banach, closed graph, and open mapping theorems.

Differential Geometry

Dates: Jan–May, 2017 Course Number: MATH 482 School: University of San Francisco
 Grade: A Credit: 4 Instructor: Dr. Tristan Needham
 Textbooks: Barrett O’Neill, *Elementary Differential Geometry, 2nd Edition*, 2006 Academic Press.
 Topics: Calculus on Euclidean space, frame fields, Euclidean geometry, calculus on a surface, shape operators, geometry of surfaces in \mathbb{R}^3 , Riemannian geometry, global structure of surfaces.

MASS Geometry: Knot Theory

Dates: Aug–Dec, 2017 Course Number: MATH 497.002 School: Pennsylvania State University
 Grade: A- (A-E/F) Credit: 3 Instructor: Dr. Sergei Tabachnikov
 Textbooks: C. C. Adams, *The Knot Book*, 2004 American Mathematical Society.
 Topics: Knots and links, isotopies, wild and tame knots, polygonal knots, knot diagrams, Reidmeister moves, simple knot invariants, linking number, three-coloring, connected sum of knots, classical knot invariants, unkotting number, crossing number, torus knots, surfaces, projective plane, Klein bottle, classification of closed oriented surfaces, Seifert surfaces, genus of a knot, braid group, closure of a braid, Alexander’s and Markov’s theorems, Cauchy-Crofton formula, total curvature of closed curves, Fenchel and Fáry-Milnor theorems, Fundamental group, Van Kampen theorem, Wirtinger presentation, bracket polynomial, Jones polynomial, proof of Tait’s conjecture, Skein relations, Alexander-Conway polynomial, tensor product of vector spaces, quantum knot invariants, Yang-Baxter equation, singular knots, Vassiliev knot invariants, chord diagrams, weight systems, Lie algebras, weight systems from Lie algebras with an invariant scalar product, and Knotsevich integral.

Topology

Dates: Sep–Dec, 2020 Course Number: MATH 450 School: San Francisco State University
 Grade: A (A-E/F) Credit: 3 Instructor: Dr. Emily Clader
 Textbooks: James Munkres, *Topology, 2nd Edition*, 2000 Pearson College Div, and Michael Starbird and Francis Su, *Topology Through Inquiry* 2019 American Mathematical Society.
 Topics: Metric Spaces: open and closed sets, interior, closure, boundary of sets, connected sets, compact sets, and continuous functions. Topological Spaces: the same concepts as above, this time in the context of general topological spaces. Special Topics: knot theory, fundamental groups, Zarski topology.

DIFFERENTIAL EQUATIONS

Applied Mathematics I

Dates: Jan–May 2009 Course Number: PHYS 20800 School: National Dong Hwa University
 Grade: A+ Credit: 3 Instructor: Dr. Lin Chi Yong
 Textbooks: G. B. Arfken and H. J. Weber, *Mathematical Methods for Physicists, 6th Edition*, 2005 Academic Press, P. V. O’Neil Advanced Engineering Mathematics, *Mathematical Methods for Physicists, 7th Edition*, 2011 Cengage India, D. J. Griffiths, *Introduction to Electrodynamics, 3rd Edition*, 1988 Prentice Hall, and S. T. Thornton and J. B. Marion, *Classical Dynamics of Particles and Systems, 5th edition*, 2003 Cengage Learning.
 Topics: Elementary calculus in polar, spherical and cylindrical coordinates with applications in electrostatics. Curvilinear coordinates, vector analysis, differential operators in curvilinear coordinates, first-order differential equations (separable equations, exact differential equations, linear differential equations), second-order differential equations (the constant coefficient homogeneous and inhomogeneous linear equations) with applications to classical mechanics and electric circuits, power series solutions, Legendre equation, Legendre polynomials (its definition and properties), Power series solutions around singular points (Frobenius method).

Applied Mathematics II

Dates: Jan–May 2009 Course Number: PHYS 20900 School: National Dong Hwa University

Grade: A

Credit: 3

Instructor: Dr. Lin Chi Yong

Textbooks: G. B. Arfken and H. J. Weber, *Mathematical Methods for Physicists, 6th Edition*, 2005 Academic Press.

Topics: Finite-dimensional linear spaces, important concepts of a normed vector space, infinite-dimensional vector space (space of functions), orthogonal functions, basis and expansions, Fourier series of a function, convergence of Fourier series, Fourier cosine series and Fourier sine series of a function, integration and differentiation of Fourier series, complex Fourier series, Sturm-Liouville theory, eigenfunction expansion, Legendre polynomials, Associated Legendre functions and spherical harmonics, Bessel equation, Gamma and Beta functions, Bessel functions, special functions related to Bessel functions, integral transform, Fourier transform, Fourier integrals, convolution and applications, and Laplace transform.

STATISTICS

Statistics with Applications

Dates: Jan–May, 2018 Course Number: MATH 371 School: University of San Francisco

Grade: B+

Credit: 4

Instructor: Dr. Xuemei Chen

Textbooks: L. J. Bain and M. Engelhardt, *Introduction to Probability and Mathematical Statistics, 2nd Edition*, 1992 Brooks/Cole.

Topics: Review of probability (conditional probability, discrete random variables, continuous random variables, moment generating functions, special discrete and continuous distributions, joint discrete and continuous distributions, conditional distributions, conditional expectation, joint moment generating functions, transformation variables, limiting distributions, central limit theorem), and mathematical statistics, including t, F, and beta sampling distributions, point estimation, interval estimation (confidence intervals, pivotal quantity method), tests of hypotheses, final project: Fisher exact test.

COMBINATORICS

Combinatorics

Dates: Sept–Dec, 2016 Course Number: MATH 422 School: University of San Francisco

Grade: A

Credit: 4

Instructor: Dr. Paul Zeitz

Textbooks: R.B.J.T. Allenby and A. Slomson, *How to Count: An Introduction to Combinatorics, 2nd Edition*, 2010 Chapman and Hall.

Topics: classic combinatorics problems, permutations, combinations, applications to probability problems, multinomial theorem, counting the solutions of equations, Stirling numbers, the inclusion-exclusion principle, Catalan numbers, partitions and dot diagrams, generating functions and recurrence relations, the Hardy-Ramanujan formula, permutations as groups, symmetry groups, orbits, stabilizers, axioms for group actions, Pólya's counting theorem, Dirichlet's pigeonhole principle, Ramsey theory.

Combinatorics

Dates: Jan–May, 2019 Course Number: MATH 720 School: San Francisco State University

Grade: A (A-E/F)

Credit: 3

Instructor: Dr. Joseph Gubeladze

Textbooks: Richard A. Brualdi, *Introductory Combinatorics, 5th Edition*, 2004 Prentice Hall.

Topics: The pigeonhole principle. Counting techniques. Fundamental combinatorial objects (sets, permutations, combinations, partitions). Generating functions. Eulerian graphs and Hamiltonian graphs. Partially ordered sets. The probabilistic method.

NON-MATH COURSES

Non-mathematics courses that have substantial mathematical components.

Physics.

Mathematical Physics I

Dates: Sept–Dec 2009 Course Number: PHYS 30000 School: National Dong Hwa University

Grade: A+

Credit: 3

Instructor: Dr. Hsin-Chang Chi

Textbooks: G. B. Arfken and H. J. Weber, *Mathematical Methods for Physicists*, 6th Edition, 2005 Academic Press, M. L. Boas, *Mathematical Methods in the Physical Sciences*, 3rd Edition, 2005 Wiley, and Brown and Churchill, *Complex Variable and Applications*, 6th Edition, 1995 McGraw-Hill.

Topics: Elementary linear algebra, partial differentiations and total differentials, complex functions, Laplace and Fourier transformations, conformal mapping, and Green's function.

Quantum Field Theory II

Dates: Sept–Dec, 2011 Course Number: PHYS 8018 School: National Taiwan University

Grade: A

Credit: 3

Instructor: Dr. Jiunn-Wei Chen

Textbooks: M. E. Peskin and D. V. Schroeder, *An Introduction to Quantum Field Theory*, 1995 CRC Press, M. Srednicki, *Quantum Field Theory*, 2007 Cambridge University, and A. Zee, *Quantum Field Theory in a Nutshell*, 2010 Princeton University Press.

Topics: Loop corrections in Yukawa theory, beta functions in Yukawa theory, functional determinants, electrodynamics in Coulomb gauge, LSZ reduction for photons, path integral pair production, Klein-Gordon field, the Dirac field, spinor electrodynamics, scattering in spinor electrodynamics, spinor helicity for spinor electrodynamics, scalar electrodynamics, loop correction in spinor electrodynamics, the vertex function in spinor electrodynamics, the magnetic moment of the electron, loop corrections in scalar electrodynamics, beta functions in quantum electrodynamics, Ward identities in quantum electrodynamics, non-abelian gauge theory, the path integral for non-abelian gauge theory, Feynman rules for non-abelian gauge theory, interacting fields and Feynman diagrams, elementary processes of quantum electrodynamics, radiative corrections, functional methods, systematics of renormalization, BRST symmetry, renormalization and symmetry, the renormalization group, symmetry and symmetry breaking, minimal supersymmetric standard model, quantum Hall fluids, sigma model as effective field theories, fractional statistics, anomalies and the path integral for fermions, Chern-Simons term, topological field theory, and Chern-Simons theory.

Introduction to Particle Physics

Dates: Sept–Dec, 2011 Course Number: PHYS 5013 School: National Taiwan University

Grade: A

Credit: 3

Instructor: Dr. Yee Bob Hsiung

Textbooks: B. R. Martin and G. Shaw, *Particle Physics*, 2008 John Wiley & Sons, and D. Griffiths, *Introduction to Elementary Particles*, 2008 Wiley-VCH.

Topics: quarks and leptons, interactions and fields, symmetry and conservation laws, quarks in hadrons, lepton and quark scattering, QCD, weak interactions, electroweak and standard model, neutrino oscillations and physics beyond standard model, experimental methods.

Introduction to Differential Geometry for Physicists

Dates: Sept–Dec, 2011 Course Number: PHYS 5013 School: National Taiwan University

Grade: B+

Credit: 3

Instructor: Dr. Wu-Pei Su

Textbooks: C. Nash and S. Sen, *Topology and Geometry for Physicists*, 1983 Academic Press, M. Nakahara, *Geometry, Topology and Physics*, 1990 CRC Press, S. S. Chern, *Studies in Global Geometry and Analysis*, 1967 The Mathematical Association of America, k. Ueno, K. Shiga, and S. Morita, *A Mathematical Gift I*, 2003 American Mathematical Society, H. Flanders, *Differential forms with applications to the physical sciences* 1989 Dover Publications.

Topics: Euler characteristic, curvature of surface, Gauss-Bonnet and Poincaré-Hopf theorem, Berry phase, Berry's curvature-analysis and topology, classical tensor analysis, connection, and curvature, differential forms, homology and cohomology groups, spin Hamiltonians and fiber bundles, differential geometry of surface, global geometry of surface, geometry of fiber bundles, characteristic classes, harmonic forms, and index theorem.

Special Topics in Field Theory

Dates: Jan–May 2012 Course Number: PHYS 8027 School: National Taiwan University

Grade: A

Credit: 4

Instructor: Dr. Pei-Min Ho

Reading twelve papers in field theory, including Faddeev–Jackiw (Hamiltonian formulation), Feynman (path integral formulation), Paul Dirac (Dirac’s method and Dirac’s equation), Weinberg, Jackiw–Rebbi, Fujikawa, Wess–Zumino, Fulling, Hawking (QFT in curved spacetime and Hawking radiation), Delamotte, Polchinski (scale and conformal invariance in QFT), and Gomis–Weinberg.

Topics: This course starts with a brief intro of quantum field theory, then focuses on historical development of quantum field theory, including the original ideas of vacuum periodicity in a Yang–Mills quantum theory, path integral formalism, renormalization group, scale and conformal invariance, and quantum chromodynamics.

Computations.

Intro to Computer Science I

Dates: Jan–May 2015 Course Number: CS 110 School: University of San Francisco

Grade: A+

Credit: 4

Instructor: Dr. Cindy Thompson

Textbooks: A. B. Downey, J. Elkner, and C. Meyers, *How to Think Like a Computer Scientist: Learning with Python*, 2002 Green Tea Press.

Topics: Variables, expressions, and statements, Functions, Data types, Numpy, File I/O, Modules, Recursion, Object Oriented Programming, Exceptions, Fitting and Scientific Data Handling, and Plotting with matplotlib.

Automata Theory

Dates: Sept–Dec 2015 Course Number: CS 411 School: University of San Francisco

Grade: A (A–E/F)

Credit: 4

Instructor: Dr. David Galles

Textbooks: Harry Lewis, Christos Papadimitriou, *Elements of the Theory of Computation*, 1997 Prentice-Hall.

Topics: Sets, relations, and languages, finite automata, context-free languages, Turing machines, Undecidability, Computational Complexity, NP-complete.

Data Structures & Algorithms

Dates: Jan–May 2016 Course Number: CS 245 School: University of San Francisco

Grade: A

Credit: 4

Instructor: Dr. David Galles

Textbooks: Thomas Cormen, Charles Leiserson, Ronald Rivest, and Clifford Stein, Christos Papadimitriou, *Introduction to Algorithms*, 2009 MIT Press.

Topics: Analysis of Algorithms, Rate of growth: $O(n)$, $o(n)$, $\Omega(n)$, $\omega(n)$, $\theta(n)$, Time vs. Space, Stacks & Queues, Arrays vs. Linked Lists, Binary Trees, Binary Tree Manipulation, Ordered Binary Trees / Binary Search Trees, Heaps, Priority Queues, Sorting, Insertion Sort / Selection Sort, Merge Sort / Quicksort, Heapsort, Bucket Sort, Radix Sort, Hash Tables, Hash Functions, Open Hashing, Closed Hashing, B Trees, Graph Algorithms, Dijkstra’s Algorithm, Prim’s Algorithm, Kruskal’s Algorithm, Depth First Search, Connected Components, Maximum Flow, Dynamic Programming, AVL Trees, NP-Completeness, and Binomial Heaps.

Game Engineering

Dates: Jan–May 2016 Course Number: CS 420 School: University of San Francisco

Grade: A Credit: 4 Instructor: Dr. David Galles

Textbooks: Fletcher Dunn, and Ian Parberry, *3D Math Primer for Graphics and Game Development*, 2011 A K Peters/CRC Press.

Topics: C++ Programming, Using Modern Graphics Engines, OGRE, Object-oriented Graphics Rendering Engine, Content Creation, Using Blender: Basics, Creating 3D Models (Blender), Creating Textures and UV mapping (Blender), Rigging and Animating (Blender), Content Pipeline (Blender and OGRE), 3D Math, Introduction and Transformation Between Spaces, Linear Transformations and Homogeneous Matrices, Orientation and Quaternions, Computational Geometry and Intersection of 3D objects, Physics Engines, Scripting Languages, Writing lua programs/scripts, Integrating lua and C/C++.

Algorithms

Dates: Jan–May 2016 Course Number: CS 673 School: University of San Francisco

Grade: B+ Credit: 4 Instructor: Dr. David Galles

Textbooks: Thomas Cormen, Charles Leiserson, Ronald Rivest, and Clifford Stein, Christos Papadimitriou, *Introduction to Algorithms*, 2009 MIT Press.

Topics: Mathematical Foundations (Recurrence Relations, Proof Techniques Used in Theoretical Computer Science), Randomized Algorithms, Sorting & Selection (Heapsort, Quicksort, Randomized Quicksort, Mergesort, Selection Problem, $O(n \ln(n))$ Quicksort (worst case), sub- $O(n \ln(n))$ sorting, counting sorts, radix sort, bucket sort), Modifying Data Structures (Red/Black Trees & Interval Trees, Leftest Heaps, Fibonacci Heaps), Dynamic Programming (Relation to Divide and Conquer, Fibonacci Numbers, Matrix Chain Multiplication, Longest Common Subsequence, Polygon Triangulation), Greedy Algorithms (Scheduling, Huffman Codes, Proving Correctness, Matroids), Amortized Analysis (Basic Concepts, Aggregate method, Accounting method, Potential Method), Graph Algorithms (Graph representations, BFS / DFS, Spanning Trees, Shortest Path, Maximum Flow), String Matching, RSA & Encryption, Computational Geometry, Approximation Algorithms).

MASS Seminars

Dates: Aug–Dec, 2018 Course Number: MATH 497 School: Pennsylvania State University

Grade: A (A-E/F) Credit: 3

Instructor: Dr. Sergei Tabachnikov

Topics: Fundamental Theorem of Algebra: two topological proofs, complex analysis: Cauchy theorem and the residue formula, Euler-Maclaurin summation formula, Basel problem, Fewomials and Descartes rule, irrationality of Pi, introduction to fundamental group, basics of classical mechanics: Hamiltonian equations, Poisson bracket, Kepler's problem, introduction to mathematical billiards, Euler's theorem on rotations of space, special orthogonal group in dimension three as the real projective space, Finsler metrics and Hilbert's fourth problem, Borsuk-Ulam theorem, basics of Lie groups and Lie algebras, solving cubic equations, Abel-Ruffini theorem, Pick's formula, Farey sequences, and Frieze patterns and Conway-Coxeter theorem.

Independent Study

Dates: Jan–May, 2021 Course Number: MATH 899 School: San Francisco State University

Grade: A- (A-E/F) Credit: 3

Instructor: Dr. Chun-Kit Lai

Textbooks: L. R. Ford, *Automorphic Functions*, 1929 Chelsea Publishing Company, J. Lehner, *Discontinuous Groups*, 1964 American Mathematical Society, David Borthwick, *Spectral theory of infinite-area hyperbolic surfaces*, 2007 Springer, Alan Beardon, *The geometry of discrete groups*, 2012 Springer Science & Business Media, Svetlana Katok, *Fuchsian groups*, 1992 University of Chicago press, D. Mumford, C. Series, and D. Wright, *Indra's Pearls—The vision of Felix Klein* 2002 Cambridge, J. G. Ratcliffe, *Foundations of Hyperbolic Manifolds*. 1994 Springer New York, F. Dal'Bo, *Geodesic and Horocyclic Trajectories*, 2011 Springer-Verlag London, and Lars Ahlfors, *Möbius transformations in several dimensions*, 1981 Lecture Notes at University of Minnesota.

Topics: Euclidean geometry, spherical geometry, hyperbolic geometry, inversive geometry, isometries of hyperbolic space, geometry of discrete groups, classical discrete groups, geometric manifolds, geometric surfaces, limit sets of Fuchsian groups, and geometric orbitfolds.

Master Thesis

Dates: Sept–Dec, 2021 Course Number: MATH 898 School: San Francisco State University

Grade: In Progress Credit: 3

Instructor: Dr. Chun-Kit Lai

Textbooks: L. R. Ford, *Automorphic Functions*, 1929 Chelsea Publishing Company, J. Lehner, *Discontinuous Groups*, 1964 American Mathematical Society, David Borthwick, *Spectral theory of infinite-area hyperbolic surfaces*, 2007 Springer, Alan Beardon, *The geometry of discrete groups*, 2012 Springer Science & Business Media, Svetlana Katok, *Fuchsian groups*, 1992 University of Chicago press, D. Mumford, C. Series, and D. Wright, *Indra's Pearls—The vision of Felix Klein* 2002 Cambridge, J. G. Ratcliffe, *Foundations of Hyperbolic Manifolds*. 1994 Springer New York, F. Dal'Bo, *Geodesic and Horocyclic Trajectories*, 2011 Springer-Verlag London, and Lars Ahlfors, *Möbius transformations in several dimensions*, 1981 Lecture Notes at University of Minnesota.

Topics: Euclidean geometry, spherical geometry, hyperbolic geometry, inversive geometry, isometries of hyperbolic space, geometry of discrete groups, classical discrete groups, geometric manifolds, geometric surfaces, hyperbolic 3-manifolds, hyperbolic n -manifolds, geometrically finite n -manifolds, limit sets of Kleinian groups, and geometric orbitfolds.
