James Harbour

Curriculum Vitae

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"Find what you love and let it kill you" — Charles Bukowski

I am a freshman at the University of Virginia with a comprehensive undergraduate and graduate-level mathematics background. My primary interests are algebraic geometry and graph theory.

University of Virginia (Fall 2021 – present)

A+ **MATH 7751**, *Algebra I*, Fall 2021, Andrei Rapinchuk.
Graduate algebra course covering ring theory (Localization, PIDs, UFDs, Euclidean Domains, Group Rings) and module theory (Chain Conditions, Hilbert Basis Theorem, Modules over PIDs, Projective/Injective Modules) with a focus on categorical perspective.
Textbook: Dummit and Foote

A **MATH 7340**, *Complex Analysis*, Fall 2021, Benjamin Hayes.
Graduate complex analysis course. Topics covered include Cauchy's theorem, Cauchy integral formula, maximum modulus principle, harmonic functions, meromorphic functions, residue theory, Rouche's theorem, normal families of analytic functions, Riemann mapping theorem, Schwartz's lemma, and Schwartz's reflection principle.
Textbook: Conway's *Functions of One Complex Variable*.

A **MATH 5657**, *Bilinear Forms and Representation Theory*, Fall 2021, Mikhail Ershov.
First half of the course focused on bilinear forms. Topics in this section included symmetric, skew-symmetric, and alternating bilinear forms (with corresponding diagonalization theorems), sesquilinear and Hermitian forms, self-adjoint and unitary operators, and tensor products (universality, tensor-hom adjunction). The second half of the course covered representation theory. Topics covered included Schur's lemma, unitarizable representations, characters, orthogonality relations, group algebras, regular representation, permutation representations, and a full proof of Burnside's pq theorem.
Textbook: Steinberg's *Representation Theory of Finite Groups: An Introductory Approach*.

University of South Florida (2019 – 2021, concurrent dual enrollment during high school)

Mathematics — Algebra

A+ **MAS 6312**, *Algebra II*, Spring 2021, Brian Curtin.
Graduate algebra course covering basic ring theory (PIDs, UFDs, etc.), field theory (general field extensions, algebraic extensions, splitting fields, Artin's theorem, cyclotomic fields, radical extensions, geometric constructions), Galois theory (Galois extensions, primitive element theorem, Galois connections, Galois groups, insolubility of the quintic), and some commutative algebra (primary and radical ideals, Lasker-Noether theorem, Hilbert's basis theorem, Hilbert's Nullstellensatz).
Textbook: Isaacs' *Algebra, a Graduate Course* (16-22, 26-28, 30).

A **MAS 5301**, *Algebra I*, Fall 2020, Brian Curtin.
Graduate Algebra course covering group theory (group actions, Sylow's theorems, results regarding the symmetric and alternating groups, direct and semidirect products, solvable and nilpotent groups, Jordan-Holder theorem) and module theory (usage of Zorn's lemma, chain conditions, simple modules, Jacobson radical of a ring, Wedderburn theory).
Textbook: Isaacs' *Algebra, a Graduate Course* (1-8, 10-14).

A **MAS 4301**, *Elementary Abstract Algebra I*, Spring 2020, Brian Curtin.
Groups (cyclic groups, subgroups, quotient groups, isomorphism theorems, finitely generated abelian groups), rings and ideals.
Textbook: Fraleigh's *A First Course in Abstract Algebra*.

Mathematics — Analysis and Geometry

A+ **MAP 5345**, *Applied Partial Differential Equations*, Spring 2021, Razvan Teodorescu.
Graduate applied partial differential equations course covering Laplace's equation, general elliptic equations, linear and nonlinear wave and heat equations.
Textbook: Evans' *Partial Differential Equations*.

A+ **MTG 4302**, *Introduction to Topology*, Spring 2021, Thomas Bieske.
Point-set topology introduction covering basic topological space constructions (subspaces, product spaces, quotient spaces), connectedness, compactness, the separation axioms, and countability axioms.
Textbook: Munkres' *Topology*.

A+ **MTG 4254**, *Differential Geometry*, Fall 2020, Thomas Bieske.
Differential geometry of curves and surfaces. Curvature, Serret-Frenet frame and formulae. Regular surfaces, the Gauss map, the shape operator, fundamental forms, scalar/principal/Gaussian/mean curvature(s), Gauss-Bonnet theorem.
Textbook: O'Neill's *Elementary Differential Geometry*.

A+ **MTG 4214**, *Modern Geometry*, Spring 2020, Thomas Bieske.
Perusal through 20th and 21st century geometry research. Course began with recollection of general metric space properties and then covered topics such as geodesically accessible points, p-modulus of curve families, Hausdorff dimension, fractals, sub-Riemannian spaces, and hyperbolic spaces.
Textbook: None.

A+ **MAA 4211**, *Intermediate Analysis I*, Spring 2020, Boris Shekhtman.
Ordered fields, real number system. General metric topology, compactness, sequences and series, continuity, connectness, intermediate and mean value theorems, uniform convergence, derivatives, and the Riemann integral.
Textbook: Rudin's *Principles of Mathematical Analysis*.

Other Mathematics

A+ **MAD 4203**, *Introduction to Combinatorics*, Fall 2020, Theodore Molla.
Covered each element of the twelvefold way. Rook polynomials, ordinary and exponential generating functions, recurrence relations, the pigeonhole principle, principle of inclusion-exclusion, Burnside's lemma, and Polya counting.
Textbook: Brualdi's *Introductory Combinatorics*.

A+ **MAS 3105**, *Linear Algebra*, Fall 2019, Brendan Nagle.
Standard proof-based linear algebra course. Gaussian elimination, matrices, linear transformations, vector spaces, bases, determinants, eigenvalues, and diagonalization.
Textbook: Bretscher's *Linear Algebra with Applications*.

A+ **MGF 3301**, *Bridge to Abstract Mathematics*, Fall 2019, Brendan Nagle.
Standard "introduction to proofs" course. Topics covered included propositional logic, elementary number theory, well-ordering, strong and weak induction, naive set theory, relations, partitions and equivalence relations, and Cantor's diagonalization argument.
Textbook: Smith's *A Transition to Advanced Mathematics*.

A+ **MAC 2313**, *Calculus 3*, Fall 2019, Vanaja Venkataraman.
Vector arithmetic, partial derivatives, quadric surfaces, double and triple integration, line integration, Stokes' theorem, divergence theorem.
Textbook: Stewart's *Calculus*.

Computer Skills

Programming in python and java level: advanced
Using scientific-computing software (SageMath, Mathematica) level: medium
Using document markup software (LaTeX, Office Suite) level: advanced
Using Linux level: medium

Honors and Awards

- College Science Scholar, University of Virginia
  - Selected as one of 18 undergraduates for a research-oriented science-mentoring program.
- Echols Scholar, University of Virginia
  - Selected for Honors Program (5% of incoming freshman), waives general education requirements.
- Pi Mu Epsilon, University of South Florida (as a high-school freshman).