

Nexus Mathematics Analytics Track

Two-Year Program Syllabus

Advanced School Mathematics • Competition Readiness • Signature Preparation

Foundation builds readiness. Analytics builds mathematical power. Signature builds advanced intellectual maturity.

Program Length: two academic years. **Analytics I:** advanced Grade 6–8 students. **Analytics II:** advanced Grade 7–10 students. **Primary outcomes:** AMC 8 strength, AMC 10 foundation, full school-math coverage, and readiness for Nexus Physics Signature or Nexus Mathematics Signature.

Program Purpose

The Nexus Mathematics Analytics Track is a rigorous bridge from strong school math into advanced mathematical and scientific study. It covers the complete U.S. middle- and high-school mathematics pathway while training students to reason structurally, explain clearly, solve unfamiliar problems, and prepare for serious STEM work. The curriculum is Nexus-designed. Advanced texts, including the Art of Problem Solving series, may be used as references for depth and problem style, but the organizing framework is the Nexus pathway: **school-math mastery, structural reasoning, competition readiness, and Signature preparation.**

Core Goals

1. **Complete foundation:** arithmetic structure, algebra, geometry, Algebra II, precalculus, trigonometry, number theory, counting, probability, and introductory statistics.
2. **Competition development:** Analytics I supports a realistic pathway toward **20/25 on AMC 8** for well-prepared students; Analytics II builds AMC 10-style reasoning.
3. **Signature readiness:** students build the mathematical language for Nexus Physics Signature and the proof/problem-solving maturity for Nexus Mathematics Signature.

Nexus Approach

Understand before memorizing. Formulas are consequences of structure, not isolated facts. Students learn where methods come from and when they apply.

Structure before procedure. Students learn to see hidden factors, symmetry, invariants, proportional relationships, recursive patterns, and case structures.

Problem solving before repetition. Students choose representations, compare methods, test assumptions, and judge whether answers make sense.

Writing as thinking. Students justify steps and organize solutions, preparing for geometry proof, number theory, contest solutions, and college-level mathematics.

Nexus Method: derive the idea, connect it to prior structures, apply it to carefully selected problems, and generalize it to unfamiliar settings.

Two-Year Pathway

Level	Core Academic Focus	Target Outcome
Analytics I	Advanced middle-school math; Algebra I foundations; introductory geometry; number theory; counting and probability; AMC 8 training.	Strong school acceleration base and a realistic pathway toward high AMC 8 performance, including a 20/25 target for well-prepared students.
Analytics II	Intermediate algebra; Algebra II; proof geometry; precalculus; trigonometry; complex numbers; advanced counting/probability; AMC 10 foundation.	Readiness for advanced high-school math, Nexus Physics Signature, and Nexus Mathematics Signature.

Analytics I: Year 1 Syllabus

Target Students: advanced Grade 6–8. **Primary Goal:** deep algebraic, geometric, number-theoretic, and combinatorial foundations with strong AMC 8 preparation.

Unit	Core Topics	Nexus / Competition Emphasis
1. Arithmetic Structure	Integers, rationals, fractions, decimals, percents, ratios, rates, proportions, units, estimation, percent change.	Flexible calculation, proportional structure, unit discipline, number sense, AMC 8 accuracy.
2. Algebraic Language	Variables, expressions, distributive property, linear equations, inequalities, word-problem modeling.	Algebra as modeling; translating words, tables, diagrams, and equations.
3. Linear Relationships	Coordinate plane, slope, lines, graph interpretation, systems, distance, midpoint.	Constant-change models, graph-to-equation translation, coordinate shortcuts.
4. Exponents and Radicals	Exponent rules, negative exponents, scientific notation, roots, radicals, irrational numbers, Pythagorean applications.	Magnitude reasoning, exponent patterns, radical structure, geometry connections.
5. Factoring and Quadratics	Polynomial multiplication, special products, difference of squares, perfect-square trinomials, grouping, quadratic factoring.	Factoring as reverse structure recognition; hidden identities and integer constraints.
6. Geometry I	Lines, angles, transversals, triangle angle sum, exterior angles, isosceles/equilateral triangles, polygons, congruence basics.	Deductive angle chasing, diagram discipline, clean justification.
7. Geometry II	Area, perimeter, circles, sectors, similarity, scale factors, right triangles, coordinate area, surface area, volume.	Decomposition, invariants, similar-triangle shortcuts, shaded regions, 3D visualization.
8. Number Theory I	Divisibility, primes, GCD/LCM, relative primality, remainders, modular arithmetic, parity, last-digit cycles.	Integer structure, proof habits, divisibility traps, cyclic patterns.
9. Counting and Probability I	Fundamental counting principle, organized lists, tree diagrams, introductory permutations/combinations, complements, casework, probability.	Controlled organization, avoiding double-counting, probability by complement.
10. AMC 8 Lab	Mixed contest sets across arithmetic, algebra, geometry, number theory, counting, probability.	Time management, answer-choice strategy, error control, multiple solution methods, mock-test review.

Year 1 Expected Outcomes

Students should solve multi-step algebra and geometry problems, use number theory and counting tools, explain reasoning clearly, and approach AMC 8 problems with disciplined strategy. A consistent student who completes homework and mock-test review should have a realistic path toward approximately **20/25 on AMC 8**.

Analytics II: Year 2 Syllabus

Target Students: advanced Grade 7–10. **Primary Goal:** transition into advanced high-school mathematics, AMC 10 foundations, and Signature-level readiness.

Unit	Core Topics	Nexus / Signature Emphasis
1. Advanced Algebra Fluency	Polynomial manipulation, advanced factoring, cubes, symmetric expressions, substitution, rationalizing.	Purposeful transformation and hidden structure recognition.
2. Quadratics and Polynomials	Quadratic forms, completing square, quadratic formula, discriminant, Vieta, division, factor/remainder theorems, roots, inequalities.	Bridge between algebra, graphing, optimization, and function analysis.
3. Rational and Radical Expressions	Rational expressions, complex fractions, rational/radical equations, rational exponents, extraneous solutions, domains.	Validity tracking, domain awareness, careful symbolic reasoning.
4. Functions and Transformations	Function notation, domain/range, composition, inverses, transformations, piecewise and absolute value functions, even/odd functions.	Functions as objects; structure, transformation, input-output reasoning.
5. Exponential and Logarithmic Functions	Growth/decay, exponent laws, logarithm definitions, log laws, change of base, equations, applications.	Inverse relationships, scaling models, scientific/financial growth reasoning.
6. Sequences, Series, Induction	Arithmetic/geometric sequences, recursion, sigma notation, telescoping sums, infinite geometric series, introductory induction.	Pattern to proof; recursion, summation, and generalization.
7. Complex Numbers	Complex arithmetic, conjugates, modulus, argument, complex roots, polar form exposure, De Moivre exposure, roots of unity enrichment.	Extension of number systems; advanced algebra and precalculus readiness.
8. Trigonometry and Precalculus	Right-triangle trig, unit circle, radians, graphs, identities, angle formulas, inverse trig, laws of sines/cosines, trig equations.	Trigonometry as geometry, functions, components, and periodic modeling for physics.
9. Geometry III	Congruence/similarity proofs, triangle centers, cyclic quadrilaterals, inscribed angles, tangents/secants, power of a point, coordinate proof.	Clean proof writing; choosing synthetic, coordinate, or algebraic methods.
10. Counting, Probability, Number Theory II	Advanced permutations/combinations, binomial coefficients, Pascal, inclusion-exclusion, conditional probability, expected value, modular arithmetic, digit problems, Diophantine equations.	Systematic casework, proof-based integer reasoning, AMC 10 foundation.

Year 2 Expected Outcomes

Students should be ready for honors high-school mathematics, AP Precalculus or precalculus-level study, AMC 10 development, and entry into Nexus Physics Signature or Nexus Mathematics Signature when placement indicates readiness.

School Math Coverage

Middle School

- Integers, rational numbers, ratios, rates, percents
- Expressions, equations, inequalities, coordinate plane
- Linear relationships, functions, graph interpretation
- Geometry: angles, triangles, circles, polygons, area, volume
- Statistics, probability, data reasoning
- Exponents, radicals, scientific notation, irrational numbers

High School

- Algebra I, Geometry, Algebra II, Precalculus
- Polynomial, rational, radical, exponential, logarithmic functions
- Trigonometry, unit circle, identities, applications
- Sequences, series, complex numbers, coordinate geometry
- Counting, probability, number theory, introductory proof
- Modeling and written mathematical explanation

Signature Readiness

Nexus Physics Signature. Students build algebraic manipulation, equation solving, systems, graph interpretation, function modeling, trigonometry, vectors, proportional reasoning, scaling, units, and dimensional analysis. These tools support kinematics, Newtonian mechanics, energy, momentum, circular motion, waves, electricity and magnetism, and eventual calculus-based modeling.

Nexus Mathematics Signature. Students build algebraic structure, geometry proof, number theory, counting, probability, functions, trigonometry, complex numbers, sequences, induction, and clean solution writing. These skills prepare students for AMC 10/12 development, AIME-style problem solving, proof-based algebra and geometry, discrete mathematics, calculus, and college-level reasoning.

Competition Development Thread

Stage	Competition Focus	Habits Developed
Analytics I	AMC 8 readiness with a pathway toward 20/25 for well-prepared students.	Fast accurate arithmetic, algebraic setup, geometry visualization, number theory intuition, counting discipline, probability by complement, mock-test review.
Analytics II	AMC 10 foundation and transition to higher-level contest reasoning.	Multi-step problem solving, proof-based explanations, advanced algebra, geometry strategy, systematic casework, mixed-topic flexibility.

Recommended Student Profile and Notes

Level	Best Fit	Readiness Indicators
Analytics I	Strong Grade 6–8 students ready for non-routine problems.	Solid arithmetic, fraction/ratio comfort, willingness to write explanations, multi-step thinking.
Analytics II	Strong Grade 7–10 students ready for Algebra II, geometry depth, and precalculus foundations.	Algebra I fluency, persistence, proof readiness, interest in advanced STEM or competitions.

This is an ambitious program. Full success requires placement discipline, steady homework, cumulative review, and regular mock assessments. The 20/25 AMC 8 target is a pathway for well-prepared students, not a guarantee. Nexus may adjust pacing based on readiness while preserving the core philosophy: **depth first, structure always, speed through understanding.**

Final Program Identity: Analytics is not ordinary acceleration. It is a disciplined bridge from strong school math to advanced mathematical power, competition readiness, and Signature-level STEM maturity.