



## Summer Program 2023 Course Catalog

### COURSE LEVELS

- Level 1:** These courses are computationally oriented with a touch on proofs. They are suited for most USA math competitions (MathCounts National level, AMC10, AMC12, ARML, and the entry level of AIME).
- Level 2:** These courses are about half computational problems and half proofs. They are well suited for the hard end of AIME and the entry level of Math Olympiad contests.
- Level 3:** These courses are proof oriented. They are well suited for students who can easily pass AIME and are seriously preparing for Math Olympiad contests.
- Level 4:** These courses are proof oriented. They are well suited for USA(J)MO/IMO qualifiers.

### ALGEBRA

#### Algebra 1.5

This is an entry-level algebra course. This course develops essential algebraic skills such as factoring, recognizing roots, telescoping sums/products and rationalizing. In addition, the students will be introduced to the use of discriminants, Viète's relations, complex numbers, and symmetric polynomials in solving various problem settings. If time permits, trigonometry and fundamental inequality, such as AM-GM and Cauchy-Schwarz, will be introduced. This course covers all AMC-level algebra topics and the easy end of AIME and ARML. This course is a good fit for students with MathCounts state-level experience, AMC10/12 scores approaching AIME qualifying cuts, or an AIME score between 1 and 3.

Course Level: 1

Prerequisites: None

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
June 5 - June 23	A1.5-01-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 5 - June 23	A1.5-01-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	A1.5-02-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 26 - July 14	A1.5-02-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
July 17 - August 4	A1.5-03-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
July 17 - August 4	A1.5-03-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT

#### Algebra 2.5

This is an intermediate-level algebra course. This course studies systems of equations, discriminants, Viète's relations, symmetric polynomials, Newton's sum, and functional properties. In addition, students will be studying algebraic and analytic properties of Trigonometric functions, the relationship with complex numbers, and the root of unity. At the end of the course, the student will be introduced to (weighted) AM–GM–HM and Cauchy–Schwarz inequalities, sequence and series, and functional equations. It covers the hard end of AMC12, and the medium to hard end of ARML and AIME. It also covers the easy end of USA(J)MO. A student with an AIME score between 4 and 10 should be a good fit for this course.

Course Level: 2

Prerequisites: None

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
June 5 - June 23	A2.5-01-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 5 - June 23	A2.5-01-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	A2.5-02-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 26 - July 14	A2.5-02-PM	Mon-Fri	3:00 PM – 5:30 PM EDT
June 26 - July 14	A2.5-02-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	A2.5-02-PM3	Mon-Fri	10:00 PM – 12:30 AM EDT
July 17 - August 4	A2.5-03-AM	Mon-Fri	8:00 AM – 10:30 AM EDT
July 17 - August 4	A2.5-03-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
July 17 - August 4	A2.5-03-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT

#### Algebra 3.5

This is an Olympiad-level algebra course and a proof based course. The first part of the course focuses on the abstract algebraic structure of polynomials, such as root locations, polynomial divisibility, and irreducibility. This part also introduces the basic concept of ring theory. The second part of the course focuses on studying inequalities such as AM-GM-HM, Cauchy-Schwarz, Power-mean, Muirhead's, Schur's, and Jensen's inequalities and inequalities related to symmetric polynomials. It is also focused on techniques in inequalities such as smoothing, fudging, and ordering. The last part of the course focuses on the fundamental technique of solving functional equations. It covers all levels of USA(J)MO and any national-Olympiad-level contest, including TST and IMO. A student with a strong algebra background and an AIME score of 10 or above should consider this course. It is strongly advised that students have good experience in proof writing.

Course Level: 3

Prerequisites: Student submitted solutions to Part II of Admission Test

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
June 5 - June 23	A3.5-01-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 26 - July 14	A3.5-02-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
July 17 - August 4	A3.5-03-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT

**ALGEBRA (continued)****Abstract Algebra**

This is an introductory course to the theory and applications of linear and abstract algebra. It covers the basic structure and theory of groups, rings, and fields, including cosets, Lagrange theorem, orbits, PIDs, irreducibility, and morphisms between structures. In the second week, we will focus on the theory of matrices, including eigenvalue, minimal polynomial, similarity, rational canonical form, and Jordan canonical form. Last week of the course will be dedicated to extension fields, Galois theory, and the solvability of quintic equations. The course covers all content from the collegiate level competition and 11th-12th grade national contest of Eastern European countries. A student who easily qualifies for USA(J)MO or students who have advanced knowledge in algebra would be a good fit for this course. It is strongly advised that students could write proofs and have knowledge about matrices, the irreducibility of polynomials, groups, rings, and fields.

Course Level: 4

Prerequisites: Student submitted solutions to Part II of Admission Test

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
July 17 - August 4	A4-03-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT

**COMBINATORICS****Math Counts with Proofs**

This is an entry-level combinatorics course. This course studies the addition and multiplication principles, permutations and combinations, principle of inclusion-exclusion, probability, and graph theory. Teaches how to deal with over-counting and many useful properties of integer divisors. It also introduces mathematical proofs using the pigeonhole principle, induction, and well-ordering. It covers MathCounts, all the AMC levels, and the easy end of AIME and ARML. This course is a good fit for students with MathCounts state-level experience, AMC10/12 scores approaching AIME qualifying cuts, or AIME scores between 1 and 3.

Course Level: 1

Prerequisites: None

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
June 5 - June 23	C1-01-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 5 - June 23	C1-01-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	C1-02-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 26 - July 14	C1-02-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
July 17 - August 4	C1-03-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
July 17 - August 4	C1-03-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT

**Counting Strategies**

This is the intermediate-level combinatorics course. This course discusses counting strategies such as the addition and multiplication principles, permutations and combinations, properties of the binomial coefficients, bijections, recursions, invariant, pigeonhole, inclusion-exclusion principle, generating functions and graph theory. In addition, it covers probability theory, including linearity of expectation. It covers the hard end of AMC12, the medium to hard end of AIME and ARML, as well as the beginning USA(J)MO level. A student with an AIME score between 4 and 10 should be a good fit for this course.

Course Level: 2

Prerequisites: None

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
June 5 - June 23	C2-01-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 5 - June 23	C2-01-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	C2-02-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 26 - July 14	C2-02-PM	Mon-Fri	3:00 PM – 5:30 PM EDT
June 26 - July 14	C2-02-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	C2-02-PM3	Mon-Fri	10:00 PM – 12:30 AM EDT
July 17 - August 4	C2-03-AM	Mon-Fri	8:00 AM – 10:30 AM EDT
July 17 - August 4	C2-03-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
July 17 - August 4	C2-03-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT

**Combinatorial Arguments**

This is an Olympiad Level and proof based course. The course introduces advanced methods of mathematical proofs, including the Pigeonhole Principle, the well-ordering principle, colorings, assigning weights, bijections/mappings, recursion, counting in two ways, and combinatorial constructions. Topics may include graph theory and combinatorial geometry. A focal point of the course is combinatorial number theory. It covers all levels of USA(J)MO and any national-Olympiad-level contest, including TST and IMO. A student who is familiar with mathematics proofs and has an AIME score of 10 or above should consider this course.

Course Level: 3

Prerequisites: Student submitted solutions to Part II of Admission Test

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
June 5 - June 23	C3-01-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 26 - July 14	C3-02-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
July 17 - August 4	C3-03-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT

**COMBINATORICS (continued)****Advanced Combinatorics**

This is a survey course in advanced combinatorics. The course is an introduction to topics in extremal graph theory and the theory of planar graphs. The topics include Mantel and Turan, Kovari-Sos-Turan theorems, extremal number of sparse graphs, algebraic constructions, Euler's formula and Kuratowski's theorem, crossing numbers, and Szemerédi-Trotter theorem. In addition, topics from combinatorial geometry and additive combinatorics will be present if time permits. A student who easily qualifies for USA(J)MO or students who have advanced knowledge in algebra would be a good fit for this course. It is strongly advised that students have good experience in proof writing and are familiar with the basic definition and structure of graphs.

Course Level: 4

Prerequisites: Student submitted solutions to Part II of Admission Test

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
June 5 - June 23	C4-01-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
July 17 - August 4	C4-03-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT

**GEOMETRY****Elements of Geometry**

This is an entry-level geometry course. The course develops essential skills in computational geometry in two dimensions using Euclidean methods, including manipulation of angles and lengths and the basic properties of polygons, circles, and the relations between figures. The analytic method is also discussed. It covers MathCounts, all AMC levels, and the easy end of AIME and ARML. This course is a good fit for students with MathCounts state-level experience, AMC10/12 scores approaching AIME qualifying cuts, or AIME scores between 1 and 3.

Course Level: 1

Prerequisites: None

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
June 5 - June 23	GEO1-01-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 5 - June 23	GEO1-01-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	GEO1-02-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 26 - July 14	GEO1-02-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
July 17 - August 4	GEO1-03-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
July 17 - August 4	GEO1-03-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT

**Computational Geometry**

This is the intermediate-level geometry course. The course studies analytic techniques in solving geometry problems: coordinate geometry, vectors (2- and 3-dimensional), planes, spheres, trigonometry, and complex numbers. Features many important geometric themes: The Law of Sines and the Law of Cosines, Ptolemy's theorem, Power of Points, radical axis, Ceva's theorem, Menelaus's theorem, Stewart's theorem, Herons and Brahmaguptas formulas, Brocard points, dot product and the vector form of the Law of Cosines, 3-dimensional coordinate systems, as well as linear representation and traveling on the earth (sphere). It covers the hard end of AMC12, the medium to hard end of AIME and ARML, and the easy end of USA(J)MO. A student with an AIME score between 4 and 10 should consider this course.

Course Level: 2

Prerequisites: None

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
June 5 - June 23	GEO2-01-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 5 - June 23	GEO2-01-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	GEO2-02-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 26 - July 14	GEO2-02-PM	Mon-Fri	3:00 PM – 5:30 PM EDT
June 26 - July 14	GEO2-02-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	GEO2-02-PM3	Mon-Fri	10:00 PM – 12:30 AM EDT
July 17 - August 4	GEO2-03-AM	Mon-Fri	8:00 AM – 10:30 AM EDT
July 17 - August 4	GEO2-03-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
July 17 - August 4	GEO2-03-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT

**Geometric Proofs**

This is the Olympiad-level geometry course. The course focuses on classical topics such as concurrency, collinearity, cyclic quadrilaterals, special centers/points of triangles, and geometric constructions. The student will be introduced to the important transformations, translations, reflections, and spiral similarities, with a touch on projective and inversive geometry. It covers the hard end of AIME, all levels of USA(J)MO, and any national-Olympiad-level contest, including TST and IMO. A student with a strong background in geometry and an AIME score of 10 or above should consider this course.

Course Level: 3

Prerequisites: Student submitted solutions to Part II of Admission Test

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
June 5 - June 23	GEO3-01-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	GEO3-02-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
July 17 - August 4	GEO3-03-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT

**GEOMETRY (continued)****Projective Geometry**

This course is an introduction to projective geometry. The course starts on viewing geometric inversions from a complex analysis standpoint (conformal map). Then will move onto discussing topics from the geometry of conics, such as tangent lines, isogonal properties, directrix, and 3D sections. Lastly, the course focuses on theory and topics from projective geometry. These topics include but are not limited to Affine Transformations, Projective Plane and Cross-Ratio, 2D and 3D Projections, Duality in Projective Geometry, Theorems of Pascal and Brianchon, and involution. It is strongly advised that students have good experience in proof writing and familiar with geometry construction and theorems.

Course Level: 4

Prerequisites: Student submitted solutions to Part II of Admission Test

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
July 17 - August 4	GEO4-03-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT

**NUMBER THEORY****Number Sense**

This is the entry-level number theory course. The course focuses on developing essential ideas in number theory such as divisibility, prime factorization, numerical systems, divisors, linear Diophantine equations, GCD, LCM, division algorithm, and arithmetic functions of divisors. In addition, students will be introduced to the theory of modular arithmetic and its applications. The course covers MathCounts, all AMC levels, the easy to medium end of AIME and ARML, and some easy end of USA(J)MO. This course is a good fit for students with MathCounts state-level experience, AMC10/12 scores approaching AIME qualifying cuts, or AIME scores between 1 and 7.

Course Level: 1

Prerequisites: None

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
June 5 - June 23	NT1-01-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 5 - June 23	NT1-01-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	NT1-02-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 26 - July 14	NT1-02-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
July 17 - August 4	NT1-03-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
July 17 - August 4	NT1-03-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT

**Modular Arithmetic**

This is an Olympiad-level number theory course. The course focus on the theory and application of modular arithmetic, such as the Chinese remainder theorem, Fermat's little theorem, Euler's theorem, the order of an element, and quadratic reciprocity. It also introduces the notion of p-adic valuation and the theory of arithmetic functions. It covers the hard end of AIME, all level USAJMO/USAMO, easy to medium end of TST, and IMO. A student who qualified for AIME with a score of 10 and above or anybody who qualified for USA(J)MO should be a good fit for this course.

Course Level: 2

Prerequisites: None

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
June 5 - June 23	NT2-01-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 5 - June 23	NT2-01-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	NT2-02-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
June 26 - July 14	NT2-02-PM	Mon-Fri	3:00 PM – 5:30 PM EDT
June 26 - July 14	NT2-02-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	NT2-02-PM3	Mon-Fri	10:00 PM - 12:30 AM EDT
July 17 - August 4	NT2-03-AM	Mon-Fri	8:00 AM – 10:30 AM EDT
July 17 - August 4	NT2-03-AM2	Mon-Fri	11:00 AM – 1:30 PM EDT
July 17 - August 4	NT2-03-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT

**Number Theory**

This is an Advanced Olympiad-level number theory course. The course focuses on in-depth discussions of Diophantine equations, residue classes, quadratic reciprocity, central binomial technique, primitive roots and algebraic integer. The course also introduces the student to the notion and theory of finite fields and p-adic numbers. A student with a strong background in number theory and easily qualifies for USA(J)MO should consider this course.

Course Level: 3

Prerequisites: Student submitted solutions to Part II of Admission Test

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
June 5 - June 23	NT3-01-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
June 26 - July 14	NT3-02-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT
July 17 - August 4	NT3-03-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT

**NUMBER THEORY (continued)**

**Advanced Number Theory**

This is a survey course in advanced topics in number theory. The first week of the course will focus on the analytic side of number theory with the goal of proving the prime number theorem and a version of the Dirichlet theorem for primes in arithmetic progression. The topics include the ring of arithmetic functions, analytic continuation, Euler Product, asymptotic analysis, and the average order of arithmetic functions. The second week will be devoted to the algebraic side of number theory, introducing basic concepts of class field theory. Finally, the last week of the course will be dedicated to two special topics, depending on students' interests. These topics include but are not limited to, L-functions, class field theory, p-adic analysis, elliptic curves, modular forms, additive number theory, sieve method, anatomy of integers, q-series, hypergeometric series, partition theory, function fields, probabilistic number theory, advance asymptotic analysis, Waring problem, cryptography, Diophantine geometry, etc.

It is strongly advised that students are familiar with calculus (integration and series), complex numbers, and abstract algebra (group, field extensions, Galois theory are a plus but not required).

Course Level: 4

Prerequisites: Student submitted solutions to Part II of Admission Test

When this course is offered (choose one):

Session Date	Section	Meeting Days	Time
July 17 - August 4	NT4-03-PM2	Mon-Fri	7:00 PM – 9:30 PM EDT

**Need additional help choosing courses?** Admitted students can refer to the enrollment section of their student dashboard for course selection tips and sample problems from each course.