Algebra II | A2

Algebra II emphasizes polynomial, rational and exponential expressions, equations, and functions. This course also introduces students to the complex number system, basic trigonometric functions, and foundational statistics skills such as interpretation of data and making statistical inferences. Students build upon previous knowledge of equations and inequalities to reason, solve, and represent equations and inequalities numerically and graphically.

The major work of Algebra II is from the following domains and clusters:

- **The Real Number System**
  - Extend the properties of exponents to rational exponents.
- **Seeing Structure in Expressions**
  - Interpret the structure of expressions.
  - Use expressions in equivalent forms to solve problems.
- **Arithmetic with Polynomials and Rational Expressions**
  - Understand the relationship between zeros and factors of polynomials.
- **Reasoning with Equations and Inequalities**
  - Understand solving equations as a process of reasoning and explain the reasoning.
  - Represent and solve equations graphically.
- **Interpreting Functions**
  - Interpret functions that arise in applications in terms of the context.
- **Building Functions**
  - Build a function that models a relationship between two quantities.
- **Making Inferences and Justifying Conclusions**
  - Make inferences and justify conclusions from sample surveys, experiments, and observational studies.

Supporting work is from the following domains and clusters:

- **Quantities**
  - Reason quantitatively and use units to solve problems.
- **The Complex Number System**
  - Perform arithmetic operations with complex numbers.
  - Use complex numbers in quadratic equations.
- **Arithmetic with Polynomials and Rational Expressions**
  - Use polynomial identities to solve problems.
  - Rewrite rational expressions.
- **Creating Equations**
  - Create equations that describe numbers or relationships.
- **Reasoning with Equations and Inequalities**
  - Solve equations and inequalities in one variable.
  - Solve systems of equations.
- **Interpreting Functions**
  - Analyze functions using different representations.
- **Building Functions**
  - Build new functions from existing functions.
- **Linear, Quadratic, and Exponential Models**
  - Construct and compare linear, quadratic, and exponential models and solve problems.
  - Interpret expressions for functions in terms of the situation they model.

- **Trigonometric Functions**
  - Extend the domain of trigonometric functions using the unit circle.
  - Prove and apply trigonometric identities.
- **Interpreting Categorical and Quantitative Data**
  - Summarize, represent, and interpret data on a single count or measurement variable.
  - Summarize, represent, and interpret data on two categorical and quantitative variables.
- **Conditional Probability and the Rules of Probability**
  - Understand independence and conditional probability and use them to interpret data.
  - Use the rules of probability to compute probabilities of compound events in a uniform probability model.

Mathematical Modeling

Mathematical Modeling is a Standard for Mathematical Practice (MP4) and a Conceptual Category. Specific modeling standards appear throughout the high school standards indicated with a star (★). Where an entire domain is marked with a star, each standard in that domain is a modeling standard.

Standards for Mathematical Practice

Being successful in mathematics requires the development of approaches, practices, and habits of mind that need to be in place as one strives to develop mathematical fluency, procedural skills, and conceptual understanding. The Standards for Mathematical Practice are meant to address these areas of expertise that teachers should seek to develop in their students. These approaches, practices, and habits of mind can be summarized as "processes and proficiencies" that successful mathematicians have as a part of their work in mathematics. Additional explanations are included in the main introduction of these standards.

Standards for Mathematical Practice
1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.

Literacy Standards for Mathematics

Communication in mathematics employs literacy skills in reading, vocabulary, speaking and listening, and writing. Mathematically proficient students communicate using precise terminology and multiple representations including graphs, tables, charts, and diagrams. By describing and contextualizing mathematics, students create arguments and support conclusions. They evaluate and critique the reasoning of others, analyze, and reflect on their own thought processes. Mathematically proficient students have the capacity to engage fully with mathematics in context by posing questions, choosing appropriate problem-solving approaches, and justifying solutions. Further explanations are included in the main introduction.

Literacy Skills for Mathematical Proficiency
1. Use multiple reading strategies. 2. Understand and use correct mathematical vocabulary. 3. Discuss and articulate mathematical ideas. 4. Write mathematical arguments.

Number and Quantity

The Real Number System (N.RN)

Cluster Headings	Content Standards	Scope & Clarifications
A. Extend the properties of exponents to rational exponents.	**A2.N.RN.A.1** Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.	*For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.* *There are no assessment limits for this standard. The entire standard is assessed in this course.*
	A2.N.RN.A.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*

Quantities★ (N.Q)

Cluster Headings	Content Standards	Scope & Clarifications
A. Reason quantitatively and use units to solve problems.	**A2.N.Q.A.1** Identify, interpret, and justify appropriate quantities for the purpose of descriptive modeling.	*Descriptive modeling refers to understanding and interpreting graphs; identifying extraneous information; choosing appropriate units; etc.* *There are no assessment limits for this standard. The entire standard is assessed in this course.*

The Complex Number System (N.CN)

Cluster Headings	Content Standards	Scope & Clarifications
A. Perform arithmetic operations with complex numbers.	**A2.N.CN.A.1** Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*

Cluster Headings	Content Standards	Scope & Clarifications
A. Perform arithmetic operations with complex numbers.	**A2.N.CN.A.2** Know and use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*
B. Use complex numbers in quadratic equations.	**A2.N.CN.B.3** Solve quadratic equations with real coefficients that have complex solutions.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*

Algebra

Seeing Structure in Expressions (A.SSE)

Cluster Headings	Content Standards	Scope & Clarifications
A. Interpret the structure of expressions.	**A2.A.SSE.A.1** Use the structure of an expression to identify ways to rewrite it.	*For example, see $2x^4 + 3x^2 - 5$ as its factors $(x^2 - 1)$ and $(2x^2 + 5)$; see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$; see $(x^2 + 4)/(x^2 + 3)$ as $((x^2 + 3) + 1)/(x^2 + 3)$, thus recognizing an opportunity to write it as $1 + 1/(x^2 + 3)$.* *Tasks are limited to polynomial, rational, or exponential expressions.*

Cluster Headings	Content Standards	Scope & Clarifications
B. Use expressions in equivalent forms to solve problems.	**A2.A.SSE.B.2** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.★ **a.** Use the properties of exponents to rewrite expressions for exponential functions.	*For example the expression 1.15^t can be rewritten as $((1.15)^{1/12})^{12t} \approx 1.012^{12t}$ to reveal that the approximate equivalent monthly interest rate is 1.2% if the annual rate is 15%.* *i) Tasks have a real-world context. As described in the standard, there is an interplay between the mathematical structure of the expression and the structure of the situation such that choosing and producing an equivalent form of the expression reveals something about the situation.* *ii) Tasks are limited to exponential expressions with rational or real exponents.*
	A2.A.SSE.B.3 Recognize a finite geometric series (when the common ratio is not 1), and know and use the sum formula to solve problems in context.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*

Arithmetic with Polynomials and Rational Expressions (A.APR)

Cluster Headings	Content Standards	Scope & Clarifications
A. Understand the relationship between zeros and factors of polynomials.	**A2.A.APR.A.1** Know and apply the Remainder Theorem: For a polynomial $p(x)$ and a number a, the remainder on division by $x – a$ is $p(a)$, so $p(a) = 0$ if and only if $(x – a)$ is a factor of $p(x)$.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*
	A2.A.APR.A.2 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.	*Tasks include quadratic, cubic, and quartic polynomials and polynomials for which factors are not provided. For example, find the zeros of $(x^2 - 1)(x^2 + 1)$.*

Cluster Headings	Content Standards	Scope & Clarifications
B. Use polynomial identities to solve problems.	**A2.A.APR.B.3** Know and use polynomial identities to describe numerical relationships.	*For example, compare (31)(29) = (30 + 1) (30 – 1) = $30^2 – 1^2$ with (x + y) (x – y) = $x^2 – y^2$.* *There are no assessment limits for this standard. The entire standard is assessed in this course.*
C. Rewrite rational expressions.	**A2.A.APR.C.4** Rewrite rational expressions in different forms.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*

Creating Equations★ (A.CED)

Cluster Headings	Content Standards	Scope & Clarifications
A. Create equations that describe numbers or relationships.	**A2.A.CED.A.1** Create equations and inequalities in one variable and use them to solve problems.	*Include equations arising from linear and quadratic functions, and rational and exponential functions.* *Tasks have a real-world context.*
	A2.A.CED.A.2 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.	*i) Tasks are limited to square root, cube root, polynomial, rational, and logarithmic functions.* *ii) Tasks have a real-world context.*

Reasoning with Equations and Inequalities (A.REI)

Cluster Headings	Content Standards	Scope & Clarifications
A. Understand solving equations as a process of reasoning and explain the reasoning.	**A2.A.REI.A.1** Explain each step in solving an equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.	*Tasks are limited to square root, cube root, polynomial, rational, and logarithmic functions.*
	A2.A.REI.A.2 Solve rational and radical equations in one variable, and identify extraneous solutions when they exist.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*

Cluster Headings	Content Standards	Scope & Clarifications
B. Solve equations and inequalities in one variable.	**A2.A.REI.B.3** Solve quadratic equations and inequalities in one variable. **a**. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, knowing and applying the quadratic formula, and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.	*In the case of equations that have roots with nonzero imaginary parts, students write the solutions as $a \pm bi$ for real numbers a and b.*
C. Solve systems of equations.	**A2.A.REI.C.4** Write and solve a system of linear equations in context.	*When solving algebraically, tasks are limited to systems of at most three equations and three variables. With graphic solutions, systems are limited to only two variables.*
	A2.A.REI.C.5 Solve a system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*
D. Represent and solve equations graphically.	**A2.A.REI.D.6** Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the approximate solutions using technology. ⋆	*Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.* *Tasks may involve any of the function types mentioned in the standard.*

Functions

Interpreting Functions (F.IF)

Cluster Headings	Content Standards	Scope & Clarifications
A. Interpret functions that arise in applications in terms of the context.	**A2.F.IF.A.1** For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. ⋆	*Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.* *i) Tasks have a real-world context.* *ii) Tasks may involve square root, cube root, polynomial, exponential, and logarithmic functions.*
	A2.F.IF.A.2 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.⋆	*i) Tasks have a real-world context.* *ii) Tasks may involve polynomial, exponential, and logarithmic functions.*
B. Analyze functions using different representations.	**A2.F.IF.B.3** Graph functions expressed symbolically and show key features of the graph, by hand and using technology.⋆ **a**. Graph square root, cube root, and piecewise defined functions, including step functions and absolute value functions. **b.** Graph polynomial functions, identifying zeros when suitable factorizations are available and showing end behavior. **c.** Graph exponential and logarithmic functions, showing intercepts and end behavior.	*A2.F.IF.B.3a: Tasks are limited to square root and cube root functions. The other functions are assessed in Algebra 1.*

Cluster Headings	Content Standards	Scope & Clarifications
B. Analyze functions using different representations.	**A2.F.IF.B.4** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. **a.** Know and use the properties of exponents to interpret expressions for exponential functions.	*For example, identify percent rate of change in functions such as $y = 2^x$, $y = (1/2)^x$, $y = 2^{-x}$, $y = (1/2)^{-x}$.* *There are no assessment limits for this standard. The entire standard is assessed in this course.*
	A2.F.IF.B.5 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).	*Tasks may involve polynomial, exponential, and logarithmic functions.*

Building Functions (F.BF)

Cluster Headings	Content Standards	Scope & Clarifications
A. Build a function that models a relationship between two quantities.	**A2.F.BF.A.1** Write a function that describes a relationship between two quantities.★ **a.** Determine an explicit expression, a recursive process, or steps for calculation from a context. **b.** Combine standard function types using arithmetic operations.	*For example, given cost and revenue functions, create a profit function.* *For A2.F.BF.A.1a:* *i) Tasks have a real-world context.* *ii) Tasks may involve linear functions, quadratic functions, and exponential functions.*
	A2.F.BF.A.2 Know and write arithmetic and geometric sequences with an explicit formula and use them to model situations.★	*There are no assessment limits for this standard. The entire standard is assessed in this course.*
B. Build new functions from existing functions.	**A2.F.BF.B.3** Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.	*i) Tasks may involve polynomial, exponential, and logarithmic functions.* *ii) Tasks may involve recognizing even and odd functions.*
	A2.F.BF.B.4 Find inverse functions. **a**. Find the inverse of a function when the given function is one-to-one.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*

Linear, Quadratic, and Exponential Models★ (F.LE)

Cluster Headings	Content Standards	Scope & Clarifications
A. Construct and compare linear, quadratic, and exponential models and solve problems.	**A2.F.LE.A.1** Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*
	A2.F.LE.A.2 For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*
B. Interpret expressions for functions in terms of the situation they model.	**A2.F.LE.B.3** Interpret the parameters in a linear or exponential function in terms of a context.	*For example, the equation $y = 5000(1.06)^x$ models the rising population of a city with 5000 residents when the annual growth rate is 6 percent. What will be the effect on the equation if the city's growth rate was 7 percent instead of 6 percent?* *There are no assessment limits for this standard. The entire standard is assessed in this course.*

Trigonometric Functions (F.TF)

Cluster Headings	Content Standards	Scope & Clarifications
A. Extend the domain of trigonometric functions using the unit circle.	**A2.F.TF.A.1** Understand and use radian measure of an angle. **a.** Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle. **b.** Use the unit circle to find *sin* θ, *cos* θ, and *tan* θ when θ is a commonly recognized angle between 0 and 2π.	*Commonly recognized angles include all multiples nπ /6 and nπ /4, where n is an integer.* *There are no assessment limits for this standard. The entire standard is assessed in this course.*
	A2.F.TF.A.2 Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*

Cluster Headings	Content Standards	Scope & Clarifications
B. Prove and apply trigonometric identities.	**A2.F.TF.B.3** Know and use trigonometric identities to to find values of trig functions. **a.** Given a point on a circle centered at the origin, recognize and use the right triangle ratio definitions of *sin* θ, *cos* θ, and *tan* θ to evaluate the trigonometric functions. **b.** Given the quadrant of the angle, use the identity sin^2 θ + cos^2 θ = 1 to find *sin* θ given *cos* θ, or vice versa.	*Commonly recognized angles include all multiples nπ /6 and nπ /4, where n is an integer.* *There are no assessment limits for this standard. The entire standard is assessed in this course.*

Statistics and Probability

Interpreting Categorical and Quantitative Data (S.ID)

Cluster Headings	Content Standards	Scope & Clarifications
A. Summarize, represent, and interpret data on a single count or measurement variable.	**A2.S.ID.A.1** Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages using the Empirical Rule.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*
B. Summarize, represent, and interpret data on two categorical and quantitative variables.	**A2.S.ID.B.2** Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. **a.** Fit a function to the data; use functions fitted to data to solve problems in the context of the data.	*Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.* *i) Tasks have a real-world context.* *ii) Tasks are limited to exponential functions with domains not in the integers.*

Making Inferences and Justifying Conclusions (S.IC)

Cluster Headings	Content Standards	Scope & Clarifications
A. Make inferences and justify conclusions from sample surveys, experiments, and observational studies.	**A2.S.IC.A.1** Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.	*For example, in a given situation, is it more appropriate to use a sample survey, an experiment, or an observational study? Explain how randomization affects the bias in a study.* *There are no assessment limits for this standard. The entire standard is assessed in this course.*
	A2.S.IC.A.2 Use data from a sample survey to estimate a population mean or proportion; use a given margin of error to solve a problem in context.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*

Conditional Probability and the Rules of Probability (S.CP)

Cluster Headings	Content Standards	Scope & Clarifications
A. Understand independence and conditional probability and use them to interpret data.	**A2.S.CP.A.1** Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").	*There are no assessment limits for this standard. The entire standard is assessed in this course.*
	A2.S.CP.A.2 Understand that two events *A* and *B* are independent if the probability of *A* and *B* occurring together is the product of their probabilities, and use this characterization to determine if they are independent.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*
	A2.S.CP.A.3 Know and understand the conditional probability of *A* given *B* as *P*(*A* and *B*)/*P*(*B*), and interpret independence of *A* and *B* as saying that the conditional probability of *A* given *B* is the same as the probability of *A*, and the conditional probability of *B* given *A* is the same as the probability of *B*.	*There are no assessment limits for this standard. The entire standard is assessed in this course.*

Cluster Headings	Content Standards	Scope & Clarifications
A. Understand independence and conditional probability and use them to interpret data.	**A2.S.CP.A.4** Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations.	*For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.* *There are no assessment limits for this standard. The entire standard is assessed in this course.*
B. Use the rules of probability to compute probabilities of compound events in a uniform probability model.	**A2.S.CP.B.5** Find the conditional probability of *A* given *B* as the fraction of *B*'s outcomes that also belong to *A* and interpret the answer in terms of the model.	*For example, a teacher gave two exams. 75 percent passed the first quiz and 25 percent passed both. What percent who passed the first quiz also passed the second quiz?* *There are no assessment limits for this standard. The entire standard is assessed in this course.*
	A2.S.CP.B.6 Know and apply the Addition Rule, *P(A or B) = P(A) + P(B) – P(A and B)*, and interpret the answer in terms of the model.	*For example, in a math class of 32 students, 14 are boys and 18 are girls. On a unit test 6 boys and 5 girls made an A. If a student is chosen at random from a class, what is the probability of choosing a girl or an A student?* *There are no assessment limits for this standard. The entire standard is assessed in this course.*

Major content of the course is indicated by the light green shading of the cluster heading and standard's coding.

	Major Content		Supporting Content