# Algebra 2

**Core Resource:** Illustrative Mathematics Algebra 2

**Semester 1**

## Unit 1: Sequences and Functions (~17 days, IM Unit 1)

**Essential Learning**

This unit provides an opportunity to revisit representations of functions (including graphs, tables, and expressions) at the beginning of the Algebra 2 course, and also introduces the concept of sequences. Through many concrete examples, students learn to identify geometric and arithmetic sequences. Beginning with an invitation to describe sequences informally, students progress to writing terms of sequences arising from mathematical situations, using representations such as tables and graphs. They progress to using function notation to define sequences recursively and then explicitly for the  term. Throughout the unit, students learn that sequences are functions and that geometric and arithmetic sequences are examples of the exponential and linear functions they learned about in previous courses, defined on a subset of the integers. In the last part of the unit, students use sequences to model several situations represented in different ways. Finally, students encounter some situations where it makes sense to compute the sum of a finite sequence. A formula for such a sum is developed in a future unit.

**Priority Standards**

**HSF-BF.A.2:** Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*

| Co-Requisite Skills/Knowledge | Non-Negotiable New Skills/Knowledge/Concepts |
|---|---|
| Differentiate between linear and exponential functions<br>Write linear equation from table and graph<br>Determine slope and y-intercept of line from 2 points<br>Graph linear equation in slope-intercept form.Students should be able to differentiate between linear and expo<br>Write an exponential function from a graph and table | Differentiate between arithmetic/geometric sequences given terms.<br>Write an explicit equation for an arithmetic and geometric sequence from a pattern and/or from a graph.<br>Generate an arithmetic and geometric sequence given an explicit equation/chart/graph<br>Write an arithmetic/geometric recursive formula given a table or graph. |

## Unit 2: Transformations of Functions (~19 days, IM Unit 5)

**Essential Learning**

In this unit, students consider functions as a whole and understand how they can be transformed to fit the needs of a situation, which is an aspect of modeling with mathematics (MP4). Students make connections between representations as they translate, reflect, and apply scale factors to different types of functions. As the unit progresses, so too does the language students use to describe transformations with precision (MP6). The unit ends with students applying transformations to different functions to model a real world data set.

**Priority Standards**

**HSF-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. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

**HSF-IF.B.4:** 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; end behavior; and periodicity.*

| Co-Requisite Skills/Knowledge | Non-Negotiable New Skills/Knowledge/Concepts |
|---|---|
| Solve a multi-step equation<br>Determine domain and range of a function given a grap | Change a standard form quadratic by completing the square to identify the vertex and graph the function<br>Model a quadratic given a contextual situation<br>Recognize if a function is even or odd from a graph/equation<br>Identify transformations given a function: quadratic, cubic, absolute value, square root, hyperbola<br>Function notation |

## Unit 3: Polynomials and Rational Functions (~31 days, IM Unit 2)

**Essential Learning**

In this unit, students expand their understanding of polynomials from linear and quadratic to those of higher degree. They are introduced to situations polynomials can model. They study graphs and equations of the same function and make connections between factors and zeros. Students learn to divide polynomials and to sketch graphs of polynomials given in factored form. Building on this work, students investigate rational functions. They learn to interpret the meaning of asymptotes in context and strategies for solving rational equations. The unit concludes with a study of polynomial identities and deriving the formula for the sum of the first  terms in a geometric sequence.

**Priority Standards**

**HSA-REI.A.2:** Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

**HSA.SSE.A.2:** Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y4 as (x2)2 – (y2)2, thus recognizing it as a difference of squares that can be factored as (x2 – y2)(x2 + y2)

**HSA-APR.B.3:** 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.

**HSF-IF.B.4:** 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; end behavior; and periodicity.*

**HSF-IF.C.7.c:** Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

| Co-Requisite Skills/Knowledge | Non-Negotiable New Skills/Knowledge/Concepts |
|---|---|
| Factor and use the Zero Product Property<br>Graph a function | Students should be able to graph a polynomial function from factored form and identify the zeros.<br>Determine end behavior from a polynomial function in factored/standard form<br>Perform polynomial long division<br>Identify vertical and horizontal asymptotes from a rational function |

**Unit 4: Complex Numbers and Rational Exponents (Part 1 ~10 days, IM Unit 3)**

**Essential Learning**

In this unit, students use what they know about exponents and radicals to extend exponent rules to include rational exponents (for example, ), solve various equations involving squares and square roots, develop the concept of complex numbers by defining a new number whose square is -1, and use complex numbers to find solutions to quadratic equations.

**Priority Standards**

**HSN-RN.A.2:** Rewrite expressions involving radicals and rational exponents using the properties of exponents.

**HSA-REI.A.2:** Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

**HSA-REI.B.4.b:** Solve quadratic equations by inspection (e.g., for x2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize

| Co-Requisite Skills/Knowledge | Non-Negotiable New Skills/Knowledge/Concepts |
|---|---|
| Properties of exponents<br>Quadratic Formula<br>Solve multi-step equations | Analyze powers of i<br>Perform arithmetic operations with complex numbers<br>Determine real and non-real solutions of a quadratic using a method of their choice |

**Semester 2**

**Unit 4: Complex Numbers and Rational Exponents (Part 2 ~10 days, IM Unit 3)**

**Essential Learning**

In this unit, students use what they know about exponents and radicals to extend exponent rules to include rational exponents (for example, ), solve various equations involving squares and square roots, develop the concept of complex numbers by defining a new number whose square is -1, and use complex numbers to find solutions to quadratic equations.

**Priority Standards**

**HSN-RN.A.2:** Rewrite expressions involving radicals and rational exponents using the properties of exponents.

**HSA-REI.A.2:** Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

**HSA-REI.B.4.b:** Solve quadratic equations by inspection (e.g., for x2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize

| Co-Requisite Skills/Knowledge | Non-Negotiable New Skills/Knowledge/Concepts |
|---|---|
| Properties of exponents<br>Quadratic Formula<br>Solve multi-step equations | Simplify fractional and negative exponents<br>Solve radical equations |

**Unit 5: Exponential Functions and Equations (~17 days, IM Unit 4)**

**Essential Learning**

In this unit, students build on their understanding of exponential functions from an earlier course. Previously, they saw functions whose domain is the integers. Here, they write, interpret, and evaluate exponential functions whose domain is the real numbers. In the second half of the unit, students learn about logarithms in base 2 and 10 as a way to express the exponent that makes an exponential equation true. They then use logarithms to solve exponential equations and to answer questions about exponential functions. During this time, students encounter the constant and learn that it is used to model situations with continuous growth rates, leading to working with the natural logarithm. The unit ends with an exposure to logarithmic functions.

**Priority Standards**

**HSF-BF.B.4.a:** Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2 x3 or f(x) = (x+1)/(x-1) for x ≠ 1.

**HSF-IF.C.7.e:** Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

**HSF-LE.A.4**: For exponential models, express as a logarithm the solution to abct = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.

| Co-Requisite Skills/Knowledge | Non-Negotiable New Skills/Knowledge/Concepts |
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|---|---|
| Be able to write an exponential equation<br>Solve a multi-step equation | Rewrite exponential as logs and vice versa<br>Use logs and natural logs to solve exponential equations<br>Use logs to solve exponential equations in real-life context<br>Find inverses of linear and quadratic equations |

**Unit 6: Trigonometric Functions (~31 days, IM Unit 6)**

**Essential Learning**

In this unit, students are introduced to trigonometric functions. While they have studied a variety of function types with different key features previously, this is the first time students are asked to consider periodic functions, that is, functions whose output values repeat at regular intervals. Students first consider circular motion and learn to use right triangle trigonometry to identify the coordinates of a point on a circle. The unit circle is introduced, and students study the symmetry of its coordinates and reason about radian angles knowing a full circle has an angle of . From the unit circle, the domain of cosine, sine, and tangent are expanded and students begin to think about them as functions. Students graph these functions using their knowledge of the unit circle and expand the domain of the functions a second time to angles beyond  and less than 0. The second half of this unit builds directly on the work of the previous unit by having students apply their knowledge of transformations to trigonometric functions and use these functions to model periodic situations.

**Priority Standards**

**HSF-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. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

**HSF-IF.B.4:** 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; end behavior; and periodicity.*

**HSF-IF.C.7.e:** Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

| Co-Requisite Skills/Knowledge | Non-Negotiable New Skills/Knowledge/Concepts |
|---|---|
| Pythagorean theorem<br>Special right triangles<br>Definitions of trig functions | Be able to convert between radians and degrees<br>Be able to determine exact coordinates on the unit circle<br>Determine angles on the unit circle based on the sine and/or cosine value<br>Be able to graph basic sine and cosine functions<br>Determine amplitude, period and transformations of a sine and cosine from a graph and equation.<br>Be able to write sine and cosine functions from basic application problems |

**Unit 7: Statistical Inferences (~17 days, IM Unit 7)**

**Essential Learning**

In grade 7, students examined processes for collecting samples from a population and using information from the samples to estimate characteristics for the population. In this unit, students expand on this idea by exploring the normal distribution and applying their understanding of the distribution to provide estimates with a margin of error. The unit also examines experimental studies, observational studies, and surveys. For experimental studies, it examines methods for analyzing the data using a randomization distribution and modeling the data with normal distributions. The importance of random selection for gathering a sample for surveys and observational studies and the importance of random assignment in experimental studies is emphasized. The unit concludes with ways to analyze the results from the various study types. Data from surveys and observational studies using random samples are used to estimate population means and proportions with a margin of error.

**Priority Standards**

**HSS-ID.A.4:** Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

| Co-Requisite Skills/Knowledge | Non-Negotiable New Skills/Knowledge/Concepts |
|---|---|
| Make a histogram | Differentiate between census and sample<br>Determine best method for random sample<br>Estimate population percentages using normal distribution<br>Determine margin of error from the standard deviation |

| Mathematical Practices | Definitions |
|---|---|
| Make sense of problems and persevere in solving them | **Co-Requisite Skills/Knowledge:** These are the skills and concepts that students should have encountered prior to the unit of study. Teachers should gather data regularly on their students and might use the Pre-Unit readiness assessments to determine their students' mastery of these skills. Based on data collected and teacher observation, these skills may need to be re-engaged with in order to best support students in learning the content in the unit. These are things that can be differentiated based on the students who need additional support or can be re-engaged whole class if necessary. |

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| Reason abstractly and quantitatively | **Priority Standards:** These are the course standards from the unit that represent the major content of the course and should be re-engaged with if students need additional support or time to master them. These are standards that we guarantee students will master before the end of the course. |
| Construct viable arguments and critique the reasoning of others | **Non-Negotiable New SKills/Knowledge/Concepts:** These are the new skills/concepts that students should know and be able to do by the completion of the unit. These are the skills/knowledge/concepts that students will be expected to have as they move into the next course. These skills/concepts are aligned to the priority standards within the unit. |
| Model with mathematics | |
| Use appropriate tools strategically | |
| Attend to precision | |
| Look for and make use of structure | |
| Look for and express regularity in repeated reasoning | |