Math Curriculum Map: Integrated Algebra II

<table>
<thead>
<tr>
<th>Unit: 1</th>
<th>Quarter:</th>
<th>Time Frame:</th>
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<tbody>
<tr>
<td>Review of Algebra</td>
<td>1</td>
<td>13 days</td>
</tr>
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</table>

**Essential Questions:**
- How does the order of operations help solve one- and two-step equations?
- How is the composition of functions related to the order of operations?
- How can the average rate of change be interpreted from a graph or a function?
- What restrictions may be necessary to the domain and range of linear equations?
- What comparisons can be made between two different functions?

**Key Concepts:**
- Simplifying expressions using order of operations
- Solving equations; one-/two-step and variables on both sides
- Determine when it is necessary to apply distributive property
- Compare and contrast different types of equations
- Identify useful methods for creating the equation of a line
- Interpret key features in terms of quantities

**Priority Standards:**
- **A1.A-CED.A.1** Create equations and inequalities in one variable and use them to solve problems. Include problem-solving opportunities utilizing real-world context. Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step).
- **A1.F-IF.A.1** Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If \( f \) is a function and \( x \) is an element of its domain, then \( f(x) \) denotes the output of \( f \) corresponding to the input \( x \). The graph of \( f \) is the graph of the equation \( y = f(x) \).
- **A1.F-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. Include problem-solving opportunities utilizing real-world context. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums. Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step).
- **A1.F-IF.B.6** Calculate and interpret the average rate of change of a continuous function (presented symbolically or as a table) on a closed interval. Estimate the rate of change

**Key Vocabulary:**
- order of operations, opposite operation, function, domain, range, degree, vertical line test, function notation, inverse function, composition of functions, coordinate plane, vertical line, horizontal line, standard form of a linear equation, slope-intercept form of a linear equation

**Supporting Standards:**
- **A2.N-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data display, include utilizing real-world context.
- **A2.N-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. Include problem-solving opportunities utilizing real-world context.
- **A2.N-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities utilizing real-world context.
- **MP.1** – Make sense of problems and persevere in solving them.
- **MP.2** – Reason abstractly and quantitatively.
- **MP.3** – Construct viable arguments and critique the reasoning of others.
- **MP.4** – Model with mathematics.
- **MP.5** – Use appropriate tools strategically.
<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>A1.F-IF.C.7</strong></td>
<td>Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step).</td>
</tr>
<tr>
<td><strong>A1.F-IF.C.9</strong></td>
<td>Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step).</td>
</tr>
<tr>
<td><strong>A2.F-BF.A.1</strong></td>
<td>Write a function that describes a relationship between two quantities. Include problem-solving opportunities utilizing real-world context. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.</td>
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<td><strong>A2.F-BF.B.4</strong></td>
<td>Find inverse functions.</td>
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<tr>
<td>a.</td>
<td>Understand that an inverse function can be obtained by expressing the dependent variable of one function as the independent variable of another, recognizing that functions f and g are inverse functions if and only if f(x) = y and g(y) = x for all values of x in the domain of f and all values of y in the domain of g.</td>
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<tr>
<td>b.</td>
<td>Understand that if a function contains a point (a, b), then the graph of the inverse relation of the function contains the point (b, a).</td>
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<tr>
<td>c.</td>
<td>Interpret the meaning of and relationship between a function and its inverse utilizing real-world context.</td>
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- **MP.6** – Attend to precision.
- **MP.7** – Look for and make use of structure.
- **MP.8** – Look for and express regularity in repeated reasoning.
Unit: 2
Quarter: 1
Time Frame: 19 days

### Essential Questions:
- How can the properties of rational exponents be applied to simplify expressions with radicals or rational exponents?
- What reasoning and explanations can be used when solving radical equations?
- What causes the need for imaginary numbers?
- How can the associative, commutative, and distributive properties be applied when performing operations on complex numbers?
- What similarities exist between the operations on polynomials and the operations on functions?

### Key Concepts:
- Rewrite expressions in either radical form or rational exponent form to fit the other form
- Solve radical equations; include extraneous solutions
- Complex numbers; include conjugates of complex numbers
- Classify polynomials based on the number of terms and the degree of the terms

### Key Vocabulary:
- Equivalent expressions, product of a power property, quotient of a power property, power of a power property, imaginary numbers, complex numbers, rationalizing the denominator, standard form of a polynomial, degree of a polynomial

### Priority Standards:
- **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 notation for radicals in terms of rational exponents.
- **A2.N-RN.A.2** Rewrite expressions involving radicals and rational exponents using the properties of exponents.
- **A2.N-CN.A.1** Apply the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers. Write complex numbers in the form $(a + bi)$ with $a$ and $b$ real.
- **P.N-CN.A.3** Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.
- **A2.A-REI.A.1** Explain each step in solving an equation as following from the equalities 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. Extend from quadratic equations to rational and radical equations.
- **A2.A-REI.A.2** Solve rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

### Supporting Standards:
- **A2.N-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data display, include utilizing real-world context.
- **A2.N-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. Include problem-solving opportunities utilizing real-world context.
- **A2.N-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities utilizing real-world context.
- **MP.1** – Make sense of problems and persevere in solving them.
- **MP.2** – Reason abstractly and quantitatively.
- **MP.3** – Construct viable arguments and critique the reasoning of others.
- **MP.4** – Model with mathematics.
- **MP.5** – Use appropriate tools strategically.
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- **MP.7** – Look for and make use of structure.
- **MP.8** – Look for and express regularity in repeated reasoning.
### Unit: 3  
**Quarter:** 1  
**Time Frame:** 20 days

#### Essential Questions:
- In what conditions can a factored expression be factored further?
- In what ways does adding a constant or coefficient to a quadratic equation affect the graph?
- What indicators predict that a quadratic function will have a complex solution?
- How are solutions, roots, and x-intercepts of a quadratic related?

#### Key Concepts:
- Factor polynomials; include sums and differences of cubes
- Determine the methods used to solve quadratics and use fluently
- Determine the method(s) used to solve quadratic equations with complex solutions
- Graph quadratic functions and identify all key features
- Derive the equation of a parabola when given the focus and the directrix

#### Priority Standards:
- A2.A-SSE.A.2 Use the structure of an expression to identify ways to rewrite it. Focus on polynomial operations and factoring patterns.
- A2.A-REI.B.4 Fluently solve quadratic equations in one variable. Solve quadratic equations by inspection, taking square roots, completing the square, the quadratic formula and factoring. Recognize when the quadratic formula gives complex solutions.
- A2.F-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. Include problem-solving opportunities utilizing real-world context. Key features include: intercepts, intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.
- A2.F-IF.B.6 Calculate and interpret the average rate of change of a continuous function (presented symbolically or as a table) on a closed interval. Include problem-solving opportunities utilizing real-world context. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

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- A2.N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities utilizing real-world context.
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● A2.F-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

● A1.F-IF.C.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. a. Use the process of factoring and completing the square of a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

● A2.F-IF.C.9 Compare properties of two functions each represents in a different way (algebraically, graphically, numerically, in tables, or by verbal descriptions). Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined 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 specified values of k (both positive and negative); find the values of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graphs using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

● MP.8 – Look for and express regularity in repeated reasoning.
# Unit: 4

## Systems of Equations and Inequalities

### Essential Questions:
- What type of solutions do the methods for solving systems of equations find?
- How can elimination and substitution adapt to solve a system with nonlinear equations?
- How can graphing be applied to solve systems of nonlinear equations?
- How can the properties of exponents help solve exponential and logarithmic equations?

<table>
<thead>
<tr>
<th>Key Concepts:</th>
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<tbody>
<tr>
<td>- Solve systems of linear equations by graphing, substitution, and elimination; include real-world context</td>
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<tr>
<td>- Solve systems of nonlinear equations; include real-world context</td>
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<tr>
<td>- Create and solve exponential equations; include real-world context</td>
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<td>- Create and solve logarithmic equations</td>
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<tr>
<td>- A1.A-REI.C.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions</td>
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<td>- A1.A-CED.A.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context.</td>
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<tr>
<td>- A2.A-REI.C.7 Solve a system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.</td>
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<td>- A2.A-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include problem-solving opportunities utilizing real-world context. Focus on equations and inequalities arising from linear, quadratic, rational, and exponential functions.</td>
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<td>- A1.A-REI.D.11 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 solutions approximately (e.g., using technology to graph the functions, make tables of values, or find successive approximations). Focus on cases where ( f(x) ) and/or ( g(x) ) are</td>
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### Priority Standards:

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<td>- Look for and express regularity in repeated reasoning.</td>
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### Time Frame:
- 2 quarters
- 16 days
linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step).

- **A2.F-BF.B.4** Find inverse functions.
  a. Understand that an inverse function can be obtained by expressing the dependent variable of one function as the independent variable of another, recognizing that functions f and g are inverse functions if and only if \( f(x) = y \) and \( g(y) = x \) for all values of \( x \) in the domain of \( f \) and all values of \( y \) in the domain of \( g \).
  b. Understand that if a function contains a point \((a, b)\), then the graph of the inverse relation of the function contains the point \((b, a)\).
  c. Interpret the meaning of and relationship between a function and its inverse utilizing real-world context.
### Unit: 5

#### Quarter:
- 2

#### Time Frame:
- 12 days

### Statistics Part 1

#### Essential Questions:
- How can you represent relationships between sets and subsets of a sample space?
- How can you determine if two events are independent?
- How can you explain the concepts of conditional probability and independence in a real-world context?
- How can the Pythagorean Identity be used to find the \( \sin \theta \), \( \cos \theta \), or \( \tan \theta \) and the quadrant location of the angle?

#### Key Concepts:

- Interpret the independent or conditional probability of two events
- Construct and Interpret two-way frequency tables
- 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
- Apply the Addition Rule
- Also, use the Pythagorean Identity to prove equations and simplify expressions

#### Key Vocabulary:
- elements, sample space, subset, events, empty set, categorical data, quantitative data, unions, intersections, complements, conditional probability, independent probability, mutually exclusive events, trigonometric identities

### Priority Standards:

#### Supporting Standards:
- A1.S-CP.A.1 Describe events as subsets of a sample space using characteristics of the outcomes, or as unions, intersections, or complements of other events.
- A1.S-CP.A.2 Use the Multiplication Rule for independent events to 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.
- A2.S-CP.A.3 Understand the conditional probability of A given B as \( P(A \text{ and } B)/P(B) \), and interpret independence of A and B as assaying 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.
- A2.S-CP.A.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to appropriate conditional probabilities.
- A2.S-CP.A.5 Recognize and explain the concepts of conditional probability and independence utilizing real-world context.
- A2.S-CP.B.6 Use Bayes Rule to 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.
- A2.N-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data display, include utilizing real-world context.
- A2.N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities utilizing real-world context.
- MP.1 – Make sense of problems and persevere in solving them.
- MP.2 – Reason abstractly and quantitatively.
- MP.3 – Construct viable arguments and critique the reasoning of others.
- MP.4 – Model with mathematics.
- MP.5 – Use appropriate tools strategically.
- MP.6 – Attend to precision.
- MP.7 – Look for and make use of structure.
| **A2.S-CP.B.7** Apply the Addition Rule, \( P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B) \), and minimum interpret the answer in terms of the model. |
| **MP.8** – Look for and express regularity in repeated reasoning. |
### Unit: 6  
**Quarter:**  
**Time Frame:**  
**Trigonometry**

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<th>Essential Questions:</th>
<th>Key Concepts:</th>
<th>Key Vocabulary:</th>
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| ● How can the radian measure of an angle determine the arc length on the unit circle?  
● How can trigonometric functions be chosen to model periodic phenomena with specified amplitude, frequency, and midline?  
● How does replacing f(x) with f(x) + k, k f(x), f(kx), and f(x + k) for specified values of k (both positive and negative) affect the graph? | ● Use the unit circle to apply trigonometric functions to all real numbers.  
● Graph trigonometric functions to show the period, midline, and amplitude.  
● Show how a function models the relationship between two quantities.  
● Find the rate of change of a function over a specified interval.  
● Determine how a function fitted to data be used to solve problems.  
● Use Pythagorean Identities to...  
  ○ Find sin θ, cos θ, or tan θ and the quadrant location of the angle.  
  ○ Prove equations  
  ○ Simplify expressions | unit circle, special right triangle identities, sine, cosine, tangent, cosecant, secant, cotangent, radian measures, arc length, ratio, terminal side, reference angles, periodic functions, domain/range, period, asymptotes, |

<table>
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<tr>
<th>Priority Standards:</th>
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| ● A2.F-TF.1 Understand radian measure of an angle as the length of an arc on the any circle subtended by the angle, measured in units of the circle’s radius.  
● A2.F-TF.2 Explain how the unit circle in the coordinate plane enables the extension of sine and cosine functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.  
● A2.F-TF.5 Create and interpret sine, cosine, and tangent trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.  
● A2.F-TF.8 Use the Pythagorean identity sin²(x) + cos²(x) = 1 and use it to find sin (x), cos (x), or tan (x) given sin (x), cos (x), or tan (x) and the quadrant of the angle. This standard lowered cognitive demand by changing “prove” to “use”.  
● A2.F-IF.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. Include problem-solving opportunities utilizing real-world context. Key features include: intercepts, intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. Functions include linear, | ● A2.N-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data display, include utilizing real-world context.  
● A2.N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities utilizing real-world context.  
● MP.1 – Make sense of problems and persevere in solving them.  
● MP.2 – Reason abstractly and quantitatively.  
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● MP.4 – Model with mathematics. |
- A2.F-IF.6 Calculate and interpret the average rate of change of a continuous function (presented symbolically or as a table) on a closed interval. Include problem-solving opportunities utilizing real-world context. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- A2.F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- A2.F-IF.9 Compare properties of two functions each represents in a different way (algebraically, graphically, numerically, in tables, or by verbal descriptions). Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- A2.F-BF.1 Write a function that describes a relationship between two quantities. Include problem-solving opportunities utilizing real-world context. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.
  
  - a. Determine an explicit expression, a recursive process, or steps for calculation from a context.
  
  - b. Combine function types using arithmetic operations and function composition.

- A2.F-BF.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 specified values of k (both positive and negative); find the values of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graphs using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- MP.5 – Use appropriate tools strategically.
- MP.6 – Attend to precision.
- MP.7 – Look for and make use of structure.
- MP.8 – Look for and express regularity in repeated reasoning.
### Unit: 7

**Quarter:** 3  
**Time Frame:** 15 days

### Dividing and Solving Polynomials

#### Essential Questions:
- What key features of a polynomial can be found using the Fundamental Theorem of Algebra and the Factor Theorem?
- How does the Remainder Theorem allow for zeros of a polynomial to be identified?
- How can the zeros and end behavior of a polynomial function allow a graph to be sketched?
- How are the solutions of a polynomial function connected to the graph?
- What key features can be identified from graphs of polynomials of higher degrees?

#### Key Concepts:
- Use long division to find the factors of polynomial functions.
- Use synthetic division to find the factors of polynomial functions.
- Determine what the Rational Root Theorem and Descartes’ Rule of Signs indicates about the zeros of a polynomial function.
- Utilize theorems in solving polynomials and their depressed equations.
- Write polynomial functions when given the zeros.
- Prove polynomial identities and apply them beyond just polynomials.

#### Key Vocabulary:
- monomial, polynomial, theorem, factored, discriminant, factorizations, Fundamental Theorem of Algebra, Factor Theorem, Remainder Theorem, long division, synthetic division, degree of a function, Rational Root Theorem, complex numbers, Descartes’ Rule of Signs, multiplicity, roots, conjugate, Conjugate Root Theorem, linear function, quadratic function, cubic function, quartic function, solutions of linear and quadratic equations, zeros

### Priority Standards:
- **A2.A-APR.2** Know and apply the Remainder and Factor Theorem.
- **A2.A-APR.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. Focus on quadratic, cubic, and quartic polynomials including polynomials for which factors are not provided.
- **A2.A-APR.4** Prove polynomial identities and use them to describe numerical relationships (Ex: difference of two squares, perfect square trinomial)
- **A2.A-REI.11** Explain why the $x$ – coordinate of the points where $g(x)$ and $f(x)$ intersect are the solutions to the equation $g(x) = f(x)$. Find the solutions algebraically and graphically. Include problems utilizing real-world context. Extend from linear, quadratic, and exponential functions to cases where $f(x)$ and/or $g(x)$ are polynomial, rational, exponential, and logarithmic.
- **A2.F-IF.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. Include problem-solving opportunities utilizing real-world context. Key features include: intercepts, intervals where the function is increasing, decreasing, positive, or negative; relative maximums

### Supporting Standards:
- **A2.N-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data display, include utilizing real-world context.
- **A2.N-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. Include problem-solving opportunities utilizing real-world context.
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- **A2.F-IF.6** Calculate and interpret the average rate of change of a continuous function (presented symbolically or as a table) on a closed interval. Include problem-solving opportunities utilizing real-world context. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- **A2.F-IF.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- **A2.F-IF.9** Compare properties of two functions each represents in a different way (algebraically, graphically, numerically, in tables, or by verbal descriptions). Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- **A2.F-BF.1** Write a function that describes a relationship between two quantities. Include problem-solving opportunities utilizing real-world context. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.
  - a. Determine an explicit expression, a recursive process, or steps for calculation from a context.
  - b. Combine function types using arithmetic operations and function composition.

- **A2.F-BF.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 specified values of k (both positive and negative); find the values of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graphs using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- **MP.6** – Attend to precision.
- **MP.7** – Look for and make use of structure.
- **MP.8** – Look for and express regularity in repeated reasoning.
### Unit: 8

#### Essential Questions:
- What are ways discontinuous points can be accounted for graphically?
- How are zeros identified in a rational expression?
- In what ways can vertical, horizontal, and oblique asymptotes be identified?
- What reasons justify a solution to a rational equation?
- How is the Fundamental Theorem of Algebra true for quadratic polynomials?

#### Key Concepts:
- Rewrite rational expressions in a simplified form.
- Add, subtract, multiply, and divide rational expressions.
- Determine if rational expressions are closed under add/subt/mult/div.
- Simplify complex fractions.
- Use rational equations in real world applications.
- Polynomial identities applications to complex numbers.
- Use Pascal’s triangle to expand binomials raised to positive integer powers.

#### Priority Standards:
- **A2.A-APR.6** Rewrite rational expressions in different forms using inspection, long division, or for the more complicated examples, a computer algebra system.
- **A2.A-CED.1** Create equations and inequalities in one variable and use them to solve problems. Include problem-solving opportunities utilizing real-world context. Focus on equations and inequalities arising from linear, quadratic, rational, and exponential functions.
- **A2.A-REI.2** Solve rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
- **A2.A-REI.11** Explain why the x – coordinate of the points where g(x) and f(x) intersect are the solutions to the equation g(x) = f(x). Find the solutions algebraically and graphically. Include problems utilizing real-world context. Extend from linear, quadratic, and exponential functions to cases where f(x) and/or g(x) are polynomial, rational, exponential, and logarithmic.
- **A2.F-IF.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. Include problem-solving opportunities utilizing real-world context. Key features include: intercepts, intervals

#### Supporting Standards:
- **A2.N-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data display, include utilizing real-world context.
- **A2.N-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. Include problem-solving opportunities utilizing real-world context.
- **A2.N-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities utilizing real-world context.
- **MP.1** Make sense of problems and persevere in solving them.
- **MP.2** Reason abstractly and quantitatively.
- **MP.3** Construct viable arguments and critique the reasoning of others.
- **MP.4** Model with mathematics.
- **MP.5** Use appropriate tools strategically.
where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- **A2.F-IF.6** Calculate and interpret the average rate of change of a continuous function (presented symbolically or as a table) on a closed interval. Include problem-solving opportunities utilizing real-world context. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- **A2.F-IF.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- **A2.F-IF.9** Compare properties of two functions each represents in a different way (algebraically, graphically, numerically, in tables, or by verbal descriptions). Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- **A2.F-BF.1** Write a function that describes a relationship between two quantities. Include problem-solving opportunities utilizing real-world context. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.
  - a. Determine an explicit expression, a recursive process, or steps for calculation from a context.
  - b. Combine function types using arithmetic operations and function composition.

- **A2.F-BF.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 specified values of k (both positive and negative); find the values of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graphs using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- **MP.6** – Attend to precision.
- **MP.7** – Look for and make use of structure.
- **MP.8** – Look for and express regularity in repeated reasoning.
<table>
<thead>
<tr>
<th>Unit: 9</th>
<th>Quarter: 4</th>
<th>Time Frame: 20 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exponential and Logarithmic Functions</td>
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</tbody>
</table>

### Essential Questions:
- What are some real-world applications for exponential functions?
- How are exponential functions related to logarithmic functions?
- How can the properties of logarithms be applied to simplify or solve equations?
- How do various parts of an exponential equation affect the entire equation?
- Why does the average rate of change vary on an exponential function?
- What effects does adding a constant have to an exponential function?
- In what ways do inverse functions relate to exponential functions and logarithmic functions?
- How do different function types compare?

### Key Concepts:
- Create exponential and logarithmic functions
- Discuss connections between properties of exponents and solving exponential/logarithmic functions
- Solve exponential equations; with equal and unequal bases
- Determine how exponential functions can be utilized to fit existing data
- Graph exponential and logarithmic functions
- Determine how transformation affect the graphs of exponential and logarithmic functions
- Combine functions

### Key Vocabulary:
- exponential function, exponential growth function, exponential decay function, logarithmic function, common logarithm, natural logarithm, change of base formula, equality property of logarithms, product property of logarithms, quotient property of logarithms, power property of logarithms, domain/range, asymptotes, end behavior,

### Priority Standards:
- **A2.N-RN.1** Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for notation for radicals in terms of rational exponents.
- **A2.N-RN.2** Rewrite expressions involving radicals and rational exponents using the properties of exponents.
- **A2.A-SSE.B.3c** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Include problem-solving opportunities utilizing real-world context and focus on expressions with rational expressions. Use the properties of exponents to transform expressions for exponential functions.
- **A2.A-CED.1** Create equations and inequalities in one variable and use them to solve problems. Include problem-solving opportunities utilizing real-world context. Focus on

### Supporting Standards:
- **A2.N-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data display, include utilizing real-world context.
- **A2.N-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. Include problem-solving opportunities utilizing real-world context.
- **A2.N-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities utilizing real-world context.
- **MP.1** – Make sense of problems and persevere in solving them.
equations and inequalities arising from linear, quadratic, rational, and exponential functions.

- **A2.A.REI.11** Explain why the x-coordinates of the points where g(x) and f(x) intersect are the solutions to the equation g(x) = f(x). Find the solutions algebraically and graphically. Include problems utilizing real-world context. Extend from linear, quadratic, and exponential functions to cases where f(x) and/or g(x) are polynomial, rational, exponential, and logarithmic.

- **A2.F.IF.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. Include problem-solving opportunities utilizing real-world context. Key features include: intercepts, intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- **A2.F.IF.6** Calculate and interpret the average rate of change of a continuous function (presented symbolically or as a table) on a closed interval. Include problem-solving opportunities utilizing real-world context. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- **A2.F.IF.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- **A2.F.IF.8** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
  - b. Use properties of exponents to interpret expressions for exponential functions and classify those functions as exponential growth and decay.

- **A2.F.IF.9** Compare properties of two functions each represents in a different way (algebraically, graphically, numerically, in tables, or by verbal descriptions). Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.

- **A2.F.BF.1** Write a function that describes a relationship between two quantities. Include problem-solving opportunities utilizing real-world context

- **MP.2** – Reason abstractly and quantitatively.
- **MP.3** – Construct viable arguments and critique the reasoning of others.
- **MP.4** – Model with mathematics.
- **MP.5** – Use appropriate tools strategically.
- **MP.6** – Attend to precision.
- **MP.7** – Look for and make use of structure.
- **MP.8** – Look for and express regularity in repeated reasoning.
<table>
<thead>
<tr>
<th><strong>A2.BF.3</strong></th>
<th>Identify the effect on the graph of replacing ( f(x) ) by ( f(x) + k ), ( k \cdot f(x) ), ( f(kx) ), and ( f(x + k) ) for specified values of ( k ) (both positive and negative); find the values of ( k ) given the graphs. Experiment with cases and illustrate an explanation of the effects on the graphs using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A2.LE.5</strong></td>
<td>Interpret the parameters in an exponential function with rational exponents utilizing real-world context.</td>
</tr>
<tr>
<td><strong>A2.ID.10</strong></td>
<td>Interpret parameters of exponential models.</td>
</tr>
<tr>
<td>Unit: 10</td>
<td>Quarter:</td>
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</tr>
<tr>
<td>Sequences and Series</td>
<td>4</td>
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</tbody>
</table>

**Essential Questions:**
- What possible restrictions exist on domains and ranges of arithmetic sequences? Or of geometric sequences?
- How do arithmetic sequences and series differ? How do geometric sequences and series differ?
- How is sigma notation used to evaluate a series?
- What must be true to find the sum of an infinite sequence?
- What key features are unique to the graphs of sequences and series?
- How can the average rate of change be found using a discrete graph?

**Key Concepts:**
- Determine an expression or process for an arithmetic and geometric sequence
- Combine functions to create an explicit formula for arithmetic sequence
- Find the sum of an arithmetic and geometric series
- Determine which functions combine to create an explicit formula for geometric sequences
- Use sigma notation to evaluate a series
- Find the sums of infinite arithmetic and geometric series
- Partial sums
- Identify convergent or divergent series
- Graph sequences and series

**Key Vocabulary:**
- arithmetic sequence, recursive, explicit, domain/range, arithmetic series, geometric sequence, discrete, continuous, exponential function, geometric series, sigma notation, partial sum, infinite divergent geometric series

**Priority Standards:**
- **A2.A-SSE.4** Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.
- **A2.F-BF.1** Write a function that describes a relationship between two quantities. Include problem-solving opportunities utilizing real-world context. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root, and piecewise-defined functions
  - a. Determine an explicit expression, a recursive process, or steps for calculation from a context.
  - b. Combine function types using arithmetic operations and function composition.

**Supporting Standards:**
- **A2.N-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data display, include utilizing real-world context.
- **A2.N-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. Include problem-solving opportunities utilizing real-world context.
- **A2.N-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities utilizing real-world context.
- **MP.1** – Make sense of problems and persevere in solving them.
- **MP.2** – Reason abstractly and quantitatively.
- **MP.3** – Construct viable arguments and critique the reasoning of others.
- **A2.F-BF.2** Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

- **MP.4** – Model with mathematics.
- **MP.5** – Use appropriate tools strategically.
- **MP.6** – Attend to precision.
- **MP.7** – Look for and make use of structure.
- **MP.8** – Look for and express regularity in repeated reasoning.
<table>
<thead>
<tr>
<th>Unit: 11</th>
<th>Quarter:</th>
<th>Time Frame:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statistics Part 2</td>
<td>4</td>
<td>8 days</td>
</tr>
</tbody>
</table>

**Essential Questions:**
- How can you use statistics to make inferences about a population based on a random sample from that population?
- How can you use surveys, experiments, and observational studies to make inferences about a population?
- How can you use data from a sample survey to estimate a population mean or proportion?
- How can we develop a margin of error through the use of simulation models for random sampling?
- How can we use simulations to decide whether differences between parameters are significant?

**Key Concepts:**
- Use the mean and standard deviation of a data set to fit in to a normal distribution and to estimate population percentages
- Determine whether a specific model is consistent with results from a data-generating process
- Define appropriate quantities for descriptive modeling
- Evaluate reports based on data
- Use data from a randomized experiment to compare two treatments

**Key Vocabulary:**
- symmetric, unimodel, standard deviation, empirical rule, population, sample, experiment, observational study, sample survey, population parameters, sample statistic, theoretical probability, empirical probability, margin of error, population mean, placebo,

**Priority Standards:**
- **A2.S-ID.4** Use the mean and the standard deviation of a data set to fit it to a normal curve 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.
- **A2.S-ID.6** Represent data of two quantitative variables on a scatter plot, and describe how the quantities are related. Extend to polynomial and exponential models.
  - a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Uses given functions, or choose a function, suggested by the context.
- **A2.S-IC.1** Understand statistics as a process for making inferences to be made about population parameters based on a random sample from that population.
- **A2.S-IC.2** Explain whether a specified model is consistent with results from a given-generating process. This standard lowered cognitive demand by changing “decide” to “explain”.
- **A2.S-IC.3** Recognize the purposes of and differences between designed experiments, sample surveys, and observational studies.

**Supporting Standards:**
- **A2.N-Q.A.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data display, include utilizing real-world context.
- **A2.N-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. Include problem-solving opportunities utilizing real-world context.
- **A2.N-Q.A.3** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities utilizing real-world context.
- **MP.1** – Make sense of problems and persevere in solving them.
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- **MP.3** – Construct viable arguments and critique the reasoning of others.
- **MP.4** – Model with mathematics.
- **MP.5** – Use appropriate tools strategically.
<table>
<thead>
<tr>
<th>A2.S-IC.4</th>
<th>Use data from a sample survey to estimate a population mean or proportion; recognize that estimates are unlikely to be correct and the estimates will be more precise with larger sample sizes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP.6</td>
<td>Attend to precision.</td>
</tr>
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<td>MP.7</td>
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