Davison Community Schools
ADVISORY CURRICULUM COUNCIL
9-12 Mathematics Courses
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Algebra 2

Course Essential Questions:

- How do we use mathematics to analyze, describe and communicate mathematical relationships and patterns?
- A primary goal of these standards is to enable students to achieve ***mathematical proficiency***. There are five components: Conceptual Understanding, Procedural Fluency, Strategic Competence, Adaptive reasoning, and Productive Disposition.

Unit 1 Functions

Essential Questions:	Essential Understandings:
• How can you determine whether a relationship is a function? • What are the different ways a function can be represented?	• A relation is a function when for every value of its domain is assigned exactly one value of its range. If given a graph it should pass the vertical line test. • A function can be represented by a rule, table, graph, a diagram and words.

Curriculum Standards

A-SSE-1. Interpret expressions that represent a quantity in terms of its context.★

a. Interpret parts of an expression, such as terms, factors, and coefficients. **(DOK 2,3)**

A-CE-1. Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* **(DOK 1,2)**

A-CE- 4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.* **(DOK 1,2)**

F-IF-5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*★ **(DOK 1,2)**

Knowledge/Content I know…	**Skills/Processes** I Can…
• The symbols for various subsets of the number system. • The various notation forms (interval, set, and summation) • Functions • Sequences • How to determine if the relation is a function given:	• Write domain and range in set notation. • Write solution sets in interval notation. • Prove/Disprove what a function is. • Write equations for sequences. • Write the terms of a sequence. • Represent a function using: ○ Symbolic(formula)

table, graph, equations or mapping diagram. • How to change forms of functions from graphical, symbolic, tabular or word to any other form. • General symbolic forms of linear functions • Graphical forms of linear functions	○ Graphs ○ Tables • Identify the functions in symbolic and graphic form. • Use technology to aid them in studying the symbolic form, tabular forms, and graphical forms of these families of functions • Identify which function will best fit with the model • Write a mathematical equation to solve • Draw a reasonable conclusion about the solution

Unit 2: Variations and Graphs

Essential Question(s)	**Essential Understanding(s)**
• What are variations? • What are the different kinds of variations?	• A variation is a function when every value of its domain is assigned exactly one value of its range. If given a graph it should pass the vertical line test. • A variation can be represented by a rule, table, graph, diagram and words.

Curriculum Standards

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. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*★ **(DOK 1,2)**

F-IF-5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*★ **(DOK 1,2)**

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.★ **(DOK 1,2)**

c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

Knowledge/Content I know…	**Skills/Processes** I Can…

• Direct Variation
• Inverse Variation
• Rate of Change/Slope
• Line of Symmetry
• Constant Variation
• Vertical/Horizontal Asymptotes
• Discrete Set
• Inverse Square Curve
• Combined Variation
• Joint Variation
• Fundamental Theorem of Variation
• Hyperbola
• Branches of Hyperbola
	• Translate variations language to formulas.
	• Solve variation problems
	• Use the Fundamental Theorem of Variation
	• Graph variation equations
	• Fit a model to data
	• Find k, and use k
	• Represent a variation using:
	  ○ Symbolic(formula)
	  ○ Graphs
	  ○ Tables
	• Identify the variations in symbolic and graphic form.
	• Use technology to aid them in studying the symbolic form, tabular forms, and graphical forms of these families of variations
	• Identify which variation will best fit with the model
	• Write a mathematical equation to solve
	• Draw a reasonable conclusion about the solution

Unit 3: Linear Functions and Sequences	
Essential Question(s) • How can be represent linear models that exist in the real-world?	**Essential Understanding(s)** • A line can be represented by equations, graphs or tables. • A data set can be modeled by a line. • A line in a data set can be used to make predictions.

Curriculum Standards

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. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*★**(DOK 1,2)**

F-IF-9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.* **(DOK 1,2)**

F-BF-1. Write a function that describes a relationship between two quantities.★ **(DOK 1,2)**

b. Combine standard function types using arithmetic operations. *For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.*

A-REI-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. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.★ **(DOK 1,2)**

A-CED-1. Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* **(DOK 1,2,3)**

A-CED-2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. **(DOK 1,2,3)**

A-CED-3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.* **(DOK 1,2)**

Knowledge/Content I know…	**Skills/Processes** I Can…
• How to identify x & y – intercepts. • General symbolic forms of linear equations, slope-intercept, point-slope form and standard form. • Graphical forms of linear equations. • Rounding down/floor functions. • Correlation/Correlation Coefficient • Line of Best fit	• Determine m & b of a line. • Find the equation of a line. • Change between slope-intercept, point slope and standard forms of linear equations. • Model situations of piecewise functions. • Evaluate explicit & recursive formulas. • Graph step functions and evaluate

• Linear Regression equation • Piecewise functions	• Model linear combination situations. • Calculate line best fit. • Predict using line best fit. • Graph a step function.

Unit 4: Systems	
Essential Question(s) • What is a system of equations and how do you to solve them? • What is a system of inequalities and how do you solve them?	**Essential Understanding(s)** • The solution can be found by graphing both equation and interpreting the results • The solution can be found by using the process of elimination or substitution • Systems of inequalities are solved the same as equations, but the solutions are inequalities with feasible regions • A three dimensional coordinate system allows you to graph points in space • Solutions can be found graphically, by elimination or substitution • Matrices can be used to solve system of equations

Curriculum Standards

A-REI-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. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.★ **(DOK 1,2)**

A-CED-2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. **(DOK 1,2,3)**

A-CED-3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.* **(DOK 1,2)**

Knowledge/Content I know…	**Skills/Processes** I Can…

• Systems of equations
  ○ Independent and dependent systems
  ○ Inconsistent systems
• Graphical method
• Solving by elimination, by substitution, using matrices
• System of inequalities
• Boundary lines
• Linear programming
• Feasible regions
	• Solve systems of linear equations using a variety of methods
	• Solve systems of inequalities and describe their feasible regions
	• Indentify and interpret the key features of the system and its solution
	• Use the method of linear program proficiency to solve systems of inequalities
	• Use matrices to solve systems of equations

Unit 5: Quadratic Functions	
Essential Question(s) • What is the complex number system? • What operations can be performed with complex numbers? • What are the key features of the graph of a function? • What affect does a translation have on a parent function? • What is the equation of a given translation? • What are the different symbolic forms of function families? • What sequence of steps is used in solving any modeling problem?	**Essential Understanding(s)** • The complex number systems are numbers in the form of a + bi where a and b are real numbers and i = √-1 . • Complex numbers can be added, subtracted, multiplied, and divided. • The key features of the graph are the x-and y-intercepts, maximums or minimums, intervals of increasing or decreasing, and asymptotes • The value of h identifies the horizontal shift and the value of k identifies the vertical shift. The value of *a* identifies stretching or shrinking or a reflection about the x – and y-axes. • The different forms are as follows: Quadratic: $y = ax^2 + bx + c$ • After having studied several function families, a student should be able to read a problem presented verbally and know from the context which function family to choose, how to represent that family symbolically, and how to manipulate the symbols to get the answer.

Curriculum Standards

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. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*★**(DOK 1,2,3)**

F-IF-5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*★ **(DOK 1,2,3)**

F-IF-9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.* **(DOK 1,2,3)**

F-BF-1. Write a function that describes a relationship between two quantities.★ **(DOK 1,2)**

b. Combine standard function types using arithmetic operations. *For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.*

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 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.***(DOK 1,2)**

N-CN-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. **(DOK 1)** **N-CN-2.** Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers. **(DOK 1,2)** **N-CN-7.** Solve quadratic equations with real coefficients that have complex solutions. **(DOK 1,2)** **A-SSE-1**. Interpret expressions that represent a quantity in terms of its context.★ **(DOK 1,2)** **A-CED-1.** Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.* **(DOK 1,2)** **F-BF-8.** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. **(DOK 1,2)** a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. **A-APR-2**. 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 $p(x)$. **(DOK 1,2)** **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. **(DOK 1,2)** **A-APR-4**. Prove polynomial identities and use them to describe numerical relationships. *For example, the polynomial identity* $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ *can be used to generate Pythagorean triples.* **(DOK 3)** **F-BF-7.** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★ **(DOK 1,2,3)** c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

Knowledge/Content I know…	**Skills/Processes** I Can…
• The imaginary number *i* is one of two solutions to $x^2 = -1$. • The complex number system: a + b*i* where a and b are real numbers and ***i*** = √-1 • The use of the quadratic formula and discriminate where applicable. • Identify zeros, and key features of a function • How to identify *h* and *k* • How to incorporate *h* and *k* into equations • General symbolic forms of quadratic functions • Graphical forms of quadratic functions	• Add, subtract, and multiply, and use complex conjugates to simplify quotients of complex numbers • Simplify complex numbers • Find zeros of functions algebraically and graphically • Identify vertical, horizontal and diagonal translations • Write equations for vertical, horizontal and diagonal functions • Identify the functions in symbolic and graphic form. • Use technology to aid them in studying the symbolic form, tabular forms, and graphical forms of these families of functions • Identify which function will best fit with the model • Write a mathematical equation to solve • Draw a reasonable conclusion about the solution

Unit 6: Powers

Essential Question(s)	Essential Understanding(s)
• What real world problems can be modeled by expressions with n^{th} powers? • What properties do n^{th} powers have? • What happens when *n* is negative? • How is compound interest figured using n^{th} power? • What type of symmetry do odd and even equations have?	• The shape of the graph changes when *n* is even or *n* is odd. Recognize: • Properties of powers in situations with the same base. • A geometric sequence is a power function. • Describe geometric sequences explicitly and recursively. • Graph n^{th} power function.

Curriculum Standards

N-Q-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.* **(DOK 1,2)**

N-Q-2. Rewrite expressions involving radicals and rational exponents using the properties of exponents. **(DOK 1,2)**

A-SSE-1. Interpret expressions that represent a quantity in terms of its context.★ **(DOK 1,2)**

a. Interpret parts of an expression, such as terms, factors, and coefficients.

b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret* $P(1+r)^n$ *as the product of P and a factor not depending on P.*

A-SSE-3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. ★**(DOK 1,2)**

c. Use the properties of exponents to transform 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 the approximate equivalent monthly interest rate if the annual rate is 15%.*

A-REI-2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. **(DOK 1,2)**

F-IF-3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. *For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.* **(DOK 1,2)**

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. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*★ **(DOK 1,2)**

F-IF-8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. **(DOK 1,2)**

b. Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, and classify them as representing exponential growth or decay.*

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.★ **(DOK 1,2)**

Knowledge/Content I know…	**Skills/Processes** I Can…
• Powering • Base • Exponent • Cubing functions • Squaring functions • Annual compound interest • Principal • Compound daily interest • Annual percentage yield (APY) • Geometric sequence • Constant multiplier • Constant ratio • Cube root, n^{th} root • Continuous interest	• Solve real world problems that can be modeled by expressions with n^{th} powers. • Graph n^{th} power functions. • Simplify expressions and solve equations using properties of exponents. • Recognize properties of n^{th} roots. • Apply compound interest formulas. • Describe geometric sequences explicitly and recursively.

Unit 7: Radical Functions	
Essential Question(s) • What is the relationship between radical form and exponential form of the algebraic expressions • What are the different ways a function can be represented? • What function operations can be used to combine functions? • Does a function have an inverse and how is it determined? • Does the inverse of a function represent a function? • What are the different symbolic forms of function families?	**Essential Understanding(s)** • Exponential expressions can be written as radical expressions and vice versa • A function can be represented by a rule, table, graph, a diagram and words. • The operations used to combine functions are addition, subtraction, multiplication, and division. • Given a table exchange x and y or given a graph reflect over the line y =x. • An inverse is a function if it passes the Vertical-Line Test or for every value of the domain, there is exactly one value of the range. • A function has an inverse if the original passes the horizontal line test. • Write the inverse of a relation/function. • Write radical notation for nth roots. • Solve equations with radicals.

Curriculum Standards

N-Q-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.* **(DOK 1,2)**

N-Q-2. Rewrite expressions involving radicals and rational exponents using the properties of exponents. **(DOK 1,2)**

A-REI-2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. **(DOK 1,2)**

Knowledge/Content I know…	**Skills/Processes** I Can…
• Rational exponents • Negative exponents • Functions can be combined using basic operations. • The process of how to determine an inverse function and whether it is a function.	• Change radical expressions to exponential expressions using rational exponents • Simplify the functions through the use of adding, subtracting, multiplying, and dividing. • Interchange x and y to produce the table or graph of the inverse • Identify an inverse as a function or not a function. • Identify the functions in symbolic and graphic form. • Use technology to aid in studying the symbolic form, tabular forms, and graphical forms of these families of functions

Unit 8: Exponential and Logarithmic Functions	
Essential Question(s) 1. How are logarithms connected to exponentials? 2. How do you use iterative processes to solve real life examples? 3. What types of real world applications involve logarithms? 4. How do you transform exponential and logarithmic expressions into equivalent forms? 5. How to solve a logarithmic equation ? 6. What affect does a translation have on the parent function of a logarithm? 7. Which family of functions has asymptote(s)? 8. What sequences of steps are used in solving any modeling problem? 9. How is the graph of an exponential function different from other function families? 10. What is the difference between an exponential function and a logarithmic function? 11. How do you change an exponential equation into a logarithmic equation? 12. How can you expand or combine a logarithm?	**Essential Understanding(s)** • A logarithm is a different way of writing an exponential. • Know some real life situations can be described using iterations. • Logarithms are used in real world applications involving pH scale, Richter scale, and decibel measurements • To transform exponential and logarithmic expressions into equivalent forms, use the properties of exponents and logarithms. • The different forms are as follows: Exponential: y = ab^x. • The families of functions that have asymptotes are exponential functions, logarithmic functions and rational functions. • After having studied several function families, a student should be able to read a problem presented verbally and know from the context which function family to choose, how to represent that family symbolically, and how to manipulate the symbols to get the answer. • The graph has a horizontal asymptote and increases or decreases rapidly. • A logarithmic function has a vertical asymptote and is reflected over the line of y = x. • Using the inverse relationship, x = $\log_b$ y becomes y = b^x . • Expanding the logarithm can be done by applying power, product, and quotient properties.

Curriculum Standards

F-BF-1. 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.* **(DOK 1,2)**
Find inverse functions.

A-REI-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. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.★**(DOK 1,2)**

A-SSE-1. Interpret expressions that represent a quantity in terms of its context.★**(DOK 1,2)**
a. Interpret parts of an expression, such as terms, factors, and coefficients.

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. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*★**(DOK 1,2)**

F-IF-5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*★**(DOK 1,2)**

F-IF-9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.***(DOK 1,2)**

F-IF-6. Rewrite simple rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, where $a(x)$, $b(x)$, $q(x)$, and $r(x)$ are polynomials with the degree of $r(x)$ less than the degree of $b(x)$, using inspection, long division, or, for the more complicated examples, a computer algebra system.**(DOK 1,2)**

A-APR-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. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.★**(DOK 1,2)**

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.★**(DOK 1,2)**

e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF-8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.**(DOK 1,2)**

b. Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as* $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, *and classify them as representing exponential growth or decay.*

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 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.***(DOK 1,2)**

A-REI-2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.**(DOK 1,2)**

Knowledge/Content I know…	**Skills/Processes** I Can…

• The connection between a base 10 logarithm and its equivalent exponential form.
• A base 10 logarithm y = log x is equivalent to $10^y = x$
• The iterative process and when to use it.
• Continuously compounded interest formula $A = Pe^{rt}$
• The connection between logarithms and real-world applications such as
  ○ Richter scale
  ○ pH scale
	• Find solutions to base 10 logarithms.
	• Use iteration process to find future values of real world applications
	• Apply $A = Pe^{rt}$
	• Compare the amounts of energy released in two earthquakes using the Richter scale
	• Find the concentration of hydrogen ions in a substance given the pH of each substance and find the pH factor given concentration of hydrogen ions

○ decibel measurements • The Laws of Exponents and Laws of Logarithms • General symbolic forms of exponential functions • Graphical forms of exponential functions. • The definitions of an asymptote and which family of functions have asymptotes • The general symbolic form of ○ Exponentials: $y = a \cdot b^x$ ○ Logarithmic: $y = \log_b x$ • The properties of exponentials • The properties of logarithms: ○ Product Property ○ Quotient Property ○ Power Property	• Determine the loudness in decibels given the intensity of sound • Apply The Laws of Exponents and Laws of Logarithms • Identify the functions in symbolic and graphic form. • Use technology to aid them in studying the symbolic form, tabular forms, and graphical forms of these families of functions Identify which function will best fit with the model • Write a mathematical equation to solve • Draw a reasonable conclusion about the solution • Generate a table and a graph given the symbolic form of an exponential • Use logarithmic properties to write an equivalent form of the equation. • Recognize the graphs of exponential and logarithmic functions.

Unit 9: Basic ideas of Trigonometry

Essential Question(s)

- What is the connection between a square and a 45-45-90 right triangle?
- What is the connection between an equilateral triangle and a 30-60-90 right triangle?
- How can the Pythagorean Theorem give us templates for special right triangles?
- What is trigonometry and how is it used?
- What are the three trigonometric functions?
- How do I find missing side lengths in a right triangle without the Pythagorean Theorem?
- How can I figure out the height of a building just by using its shadow?
- What are the Law of Sines and Law of Cosines?
- How are the Pythagorean Theorem and its converse related?
- What is the unit circle and that it has coordinates of the form,(cos θ, sin θ)
- How are the signs of cos θ and sin θ determined?
- What are the sine curve and the cosine curve?
- What does sinusoidal mean?
- What is a radian?
- Why use radians?

Essential Understanding(s)

- Cutting a square in half results in a 45-45-90 triangle.
- Constructing the altitude of an equilateral triangle results in two 30-60-90 triangles.
- Applying the Pythagorean Theorem to the square and equilateral triangle situations (above) can determine side lengths of the special right triangles.
- Trigonometry is the use established ratios that exist in right triangles.
- The charted trigonometric ratios of sine, cosine, and tangent are used to solve for missing side lengths and angles in right triangles without using the Pythagorean Theorem.
- We can use trigonometric ratios and setup right triangles to solve real-world problems such as the height of a building using its shadow.
- The Law of Sines is a relationship between the angles of *any* triangle and their opposite sides. The Law of Cosines is a method of solving for the opposite side of *any* triangle given two sides and the angle between – or – solving for a missing angle when all three side lengths are given.
- The Pythagorean Theorem uses two given side lengths of a right triangle to find the third. Its converse can prove three given side lengths form a right triangle.
- The unit circle can be used to determine the sign of any angle {θ| 0≤θ≤ 360}
- Using the unit circle to determine exact sine, cosine and tangent values for 30^0,60^0, 90^0 angles, and all multiples of them from 0^0 to 360^0

Curriculum Standards

F-TF-1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle. **(DOK 1,2)**

F-TF-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. **(DOK 1,2)**

F-TF-3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosines, and tangent for $\pi - x$, $\pi+x$, and $2\pi–x$ in terms of their values for *x*, where *x* is any real number. **(DOK 1,2)**

F-TF-4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions. **(DOK 1,2)**

F-TF-5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.★ **(DOK 1,2)**

F-TF-8. Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find sin(θ), cos(θ),or tan(θ) given sin(θ), cos(θ), or tan(θ) and the quadrant of the angle. **(DOK 1,2,3)**

Knowledge/Content I know…	**Skills/Processes** I Can…
• Special right triangles (45-45-90, 30-60-90) • Trigonometry • Sine • Cosine • Tangent • Law of Sines • Law of Cosines • Ratio • Obtuse • Acute • Right • Pythagorean Theorem • Radius • Unit Circle	• Provide an exact and approximate solution using irrational numbers. • Show how a 45-45-90 right triangle is derived from a square. • Show how a 30-60-90 right triangle is derived from an equilateral triangle. • Use the templates for special right triangles to solve for missing side lengths. • Setup the proper trigonometry ratio for a given situation. • Know the sine, cosine, and tangent ratios. • Use the trigonometry ratios to solve for missing sides and angles in right triangles. • Use trigonometry in real-world applications. • Know and use the Law of Sines and Law of Cosines to solve practical problems. • Use the converse of the Pythagorean Theorem to determine if a triangle is right, acute or obtuse. • Use the Pythagorean Theorem to solve for a missing side in a right triangle. • How to convert from degrees to radians and radians to degrees.

Unit 10: Statistics	
Essential Question(s) • What is margin of error and error tolerance? • What are the key characteristics of dot plots, histograms, relative frequency histograms, bar graphs, basic control charts, and box plots? • How do you create dot plots, histograms, relative frequency, histograms, bar graphs, basic control charts, and box plots using the key characteristics? • How do the measures of center and variation affect the shaper of a distribution? • How are measures of center calculated and interpreted within a given set of data and its context? • How are the measures of center estimated in symmetrical and skewed distribution and from a frequency distribution or histogram? • How are measures of variation computed and interpreted within a given set of data and its context? • What is the concept of distribution? • What is the relationship between the summary statistics and the parameters of a distribution? • What are the characteristics of the normal distribution? • How is the z-score computed? • How is the z-score used to determine outliers in a set of data?	**Essential Understanding(s)** ● Margin of error and the use of error tolerance are used to create a buffer between acceptable values ● The key characteristics are: min, max, Q1, Q3, mean, median, mode, standard deviation, variance, and outliers. ● To create a statistical plot use appropriate labels and scales along with the key characteristics to create dot plots, histograms, relative frequency histograms, bar graphs, basic control charts, and box plots. ● The measures of central tendency and variation affect the skewness, symmetry, and shape of a graph ● Measures of center are found by calculating the mean, median, mode. ● The measures of center are estimated by examining and applying definitions of mean, median, and mode to the varies distributions. ● Measures of variation are found by calculating the range, inner-quartile range, quartiles, percentiles, variance, and standard deviation. ● A distribution shows the pattern of data that vary randomly from the mean. ● The parameters of a distribution determine which function of the summary statistics is appropriate to use in representing the data. ● A normal distribution is a bell-shaped curve, with 68% of data within 1 standard deviation, 95% within 2 standard deviations, and 100% within 3 standard deviations. ● The z score is computed by taking a values distance from the mean and dividing by the standard deviation. ● Outliers are values that have a z-score greater than 3 or less than -3. ● A sample is used when surveying the entire population is not feasible.
Curriculum Standards	
S-ID-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. **(DOK 1,2)**	

S-IC-1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population. **(DOK 1)**

S-IC-3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. **(DOK 1)**

S-IC-4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling. **(DOK 1,2,3)**

S-IC-6. Evaluate reports based on data. **(DOK 3)**

Knowledge/Content I know…	**Skills/Processes** I Can…
● The definitions of tolerance, statistical significance, margin of error, and confidence level. ● What are: o Minimum/Maximum o Quartiles o Central Tendencies o Measures of variation ● Recognize the different types of plots that can be used to display statistical data and when each is best used for certain situations. ● About shape, symmetry, and skewness of graphs. ● The measures of center: o Mean, median, mode ● The measures of variation. o Range, Variation, Standard deviation. ● The advantages and disadvantages of each. ● Different skewed distributions. ● Positive, Negative, Symmetrical ● What a distribution looks like. ● What the summary statistics are. ● What the characteristics of the normal distribution are. ● What parameters of a distribution are. ● How standard deviation relates to the mean of a normal distribution. ● The relationship of a z-score of a data value and the data set.	• Find the measures of Central Tendency (Mean, Median & Mode) • Identify the Outlier • Determine how the outlier affects the measures of Central Tendency • Find the value at a given percentile • Use a Frequency Table to determine the measures of Central Tendency • Find the measures of Variation (Standard Deviation & Variance) • Determine the number of standard deviations that include all the data values • Find the z-score for a specified value in the set • Find the sample proportion, margin of error and confidence interval for a given situation • Find the sample size given the margin of error • Determine the appropriate sample type to use or is being used • Use the mean and standard deviation to draw a normal bell curve • Use the normal bell curve to make predictions

Unit 11: Polynomial Functions

Essential Question(s)	**Essential Understanding(s)**
• What are the key features of the graph of a function? • What are the different symbolic forms of function families? • What sequence of steps is used in solving any modeling problem?	• To perform basic operations on polynomials and rational expressions, use the laws of exponents, combining like terms, factoring,… • Dividing a polynomial by a monomial requires the use of factoring, the Laws of exponents, and the multiplicative property of one. • The key features of the graph are the x-and y-intercepts, maximums or minimums, intervals of increasing or decreasing, and asymptotes. • The different forms are as follows: Polynomial: $y = a_n x^n + a_{n-1}x^{n-1} + . . . + a_0$ • After having studied several function families, a student should be able to read a problem presented verbally and know from the context which function family to choose, how to represent that family symbolically, and how to manipulate the symbols to get the answer.

Curriculum Standards

A-SSE-1. Interpret expressions that represent a quantity in terms of its context.★ **(DOK 1,2)**

a. Interpret parts of an expression, such as terms, factors, and coefficients.

A-SSE-2. Use the structure of an expression to identify ways to rewrite it. *For example, 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* $(x^2 - y^2)(x^2 + y^2)$. **(DOK 1,2)**

A-APR-2. 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 $p(x)$. **(DOK 1,2)**

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. **(DOK 1,2)**

A-APR-4. Prove polynomial identities and use them to describe numerical relationships. *For example, the polynomial identity* $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ *can be used to generate Pythagorean triples.* **(DOK 1,2)**

A-APR-6. Rewrite simple rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, where $a(x)$, $b(x)$, $q(x)$, and $r(x)$ are polynomials with the degree of $r(x)$ less than the degree of $b(x)$, using inspection, long division, or, for the more complicated examples, a computer algebra system. **(DOK 1,2)**

A-APR-7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions. **(DOK 1)**

F-BF-4. Find inverse functions.

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,* $f(x) = 2x^3$ *or* $f(x) = (x+1)/(x-1)$ *for* $x \neq 1$. **(DOK 1,2)**

Knowledge/Content I know…	**Skills/Processes** I Can…
• General symbolic form of polynomial functions. • Graphical forms of polynomial functions • Factoring Polynomials • Zero Product Theorem • Factor Theorem • Fundamental Theorem of Algebra • Zeroes, Solution, roots of Polynomial Functions • Finding an equation for a data set	• Identify the functions in symbolic and graphic form. • Use technology to aid them in studying the symbolic form, tabular forms, and graphical forms of these families of functions. • Identify which function will best fit with the model. • Write a mathematical equation to solve. • Draw a reasonable conclusion about the solution. • Find Zeroes • Apply Zero Product Theorem • Apply Factor Theorem • Apply Fundamental Theorem of Algebra • Use Polynomials in real world situation

Unit 12: Rational Functions	
Essential Question(s) • What are the key features of the graph of a function? • What function operations can be used to combine functions? • What are the different symbolic forms of function families? • Which family of functions has asymptote(s)? • What sequence of steps are used in solving any modeling problem? • What are the key characteristics of the graph of a rational function?	**Essential Understanding(s)** ● To perform basic operations on polynomials and rational expressions, use the laws of exponents, combining like terms, factoring,… ● Dividing a polynomial by a monomial requires the use of factoring, the Laws of exponents, and the multiplicative property of one. ● The key features of the graph are the x and y-intercepts, maximums, minimums, intervals of increasing or decreasing, and asymptotes. ● The operations that you can use to combine functions are addition, subtraction, multiplication, and division. ● The family of functions that have asymptotes are exponential function, logarithmic functions and rational functions. ● After having studied several function families, a student should be able to read a problem presented verbally and know from the context which function family to choose, how to represent that family symbolically, and how to manipulate the symbols to get the answer. The graph can have vertical and horizontal asymptotes and/or point(s) of discontinuity, it can have intervals of increasing or decreasing, and key points are the x- and y-intercepts.
Curriculum Standards	

A-APR-6. Rewrite simple rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, where $a(x)$, $b(x)$, $q(x)$, and $r(x)$ are polynomials with the degree of $r(x)$ less than the degree of $b(x)$, using inspection, long division, or, for the more complicated examples, a computer algebra system. **(DOK 1,2)**

A-APR-7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions. **(DOK 1)**

A-APR-2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. **(DOK 1,2)**

A-APR-2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. **(DOK 1,2)**

A-APR-4. Find inverse functions. **(DOK 1,2)**

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,* $f(x) = 2x^3$ *or* $f(x) = (x+1)/(x-1)$ *for* $x \neq 1$.

A-APR-9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.* **(DOK 1,2)**

Knowledge/Content I know…	**Skills/Processes** I Can…
• Identify zeros, key features of a function, and describe the behavior of a function as x approaches positive or negative infinity. • Functions can be combined using basic operations. • The definition of an asymptote and which family of functions have asymptotes. • Rational functions • The symbolic form of a rational function • f(x) = p(x)/q(x) • The definition of a vertical and horizontal asymptotes and point(s) of discontinuity • The connection between symbolic form and the key characteristics of the graph: o y-intercept is the value of the function evaluated at x = 0 o x-intercept(s) are the zeros of the numerator • vertical asymptotes are the zeros of the denominator when the function is simplified	• Graph a reciprocal function • Describe and Graph the transformation of a reciprocal function • Write the equation for a reciprocal function with a transformation • Use a reciprocal function to solve a real world problem • Find points of discontinuity • Find vertical asymptotes • Find horizontal asymptotes • Graph a rational function • Simplify a rational expression • Multiply a rational expression • Divide a rational expression • Add rational expressions • Subtract rational expressions • Use rational expressions to solve a problem • Find the Least Common Multiples • Simplify complex fractions • Solve rational equations • Use rational equations to solve a real world problem

Unit 13: Quadratic Relations

Essential Question(s)

- What are the different symbolic forms of the function families?
- How are conic sections generated?
- How are points on conic sections related?
- How are equations of conic sections derived?
- How are the numeric values of the standard form of conic section equations used in graphing them?
- How do the numeric values (a, b, c) of the equation determine the orientation of the graphs?
- What are the key features of the graph of a function?
- What function operations can be used to combine functions?
- What are the different symbolic forms of function families?
- Which family of functions has asymptote(s)?
- What sequences of steps are used in solving any modeling problem?
- What are the key characteristics of the graph of a rational function?

Essential Understanding(s)

- A conic section is created by a plane cutting a double cone parallel to the bases, an edge, or the axis of the double cone.
- To perform basic operations on polynomials and rational expressions, use the laws of exponents, combining like terms, factoring,…
- Dividing a polynomial by a monomial requires the use of factoring, the Laws of exponents, and the multiplicative property of one.
- The key features of the graph are the x and y-intercepts, maximums, minimums, intervals of increasing or decreasing, and asymptotes.
- The operations that you can use to combine functions are addition, subtraction, multiplication, and division.
- The families of functions that have asymptotes are exponential function, logarithmic functions and rational functions.
- After having studied several function families, a student should be able to read a problem presented verbally and know from the context which function family to choose, how to represent that family symbolically, and how to manipulate the symbols to get the answer.
- The graph can have vertical and horizontal asymptotes and/or point(s) of discontinuity, it can have intervals of increasing or decreasing, and key points are the x- and y-intercepts.

Curriculum Standards

A-SSE-2. Use the structure of an expression to identify ways to rewrite it. *For example, 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* $(x^2 - y^2)(x^2 + y^2)$. **(DOK 1,2)**

A-APR-2. 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 $p(x)$. **(DOK 1,2)**

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. **(DOK 1,2)**

A-REI-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. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.★ **(DOK 1,2)**

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.★ **(DOK 1,2)**

c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

Knowledge/Content I know…	**Skills/Processes** I Can…

• Equations for:
    ○ ellipses
    ○ parabolas
    ○ hyperbolas
    ○ circles
• Major axis, minor axis, vertices.
• How to graph all of the conic sections.
• How to determine asymptotes for hyperbolas.
• Identify zeros, key features of a function, and describe the behavior of a function as x approaches positive or negative infinity.
• Functions can be combined using basic operations.
• The definition of an asymptote and which family of functions have asymptotes.
• Rational functions
• The symbolic form of a rational function
• $f(x) = p(x)/q(x)$
 	
• The definition of a vertical and horizontal asymptotes and point(s) of discontinuity
• The connection between symbolic form and the key characteristics of the graph:
    ○ y-intercept is the value of the function evaluated at x = 0
    ○ x-intercept(s) are the zeros of the numerator
• vertical asymptotes are the zeros of the denominator when the function is simplified
	• Identify the functions in symbolic and graphic form.
	• Use technology to aid them in studying the symbolic form, tabular forms, and graphical forms of these families of functions.
	• Recognize a conic section by its equation.
	• Find values for a, b, and c from the equation.
	• Graph a conic section.
	• Simplify the functions through the use of adding, subtracting, multiplying, and dividing.
	• Identify the functions in symbolic and graphic form.
	• Use technology to aid them in studying the symbolic form, tabular forms, and graphical forms of these families of functions
	• Identify which function will best fit with the model
	• Write a mathematical equation to solve
	• Draw a reasonable conclusion about the solution
	
	• Find the x- and y-intercepts given the symbolic or graphical form of the rational function
	• Find the horizontal and vertical asymptotes given the symbolic and graphical form of the rational function