



Grade Level: 9-12

Content: Algebra 2

Year: 2022-2023

**Course Description/Rationale**

**Prerequisite:** Algebra 1

Most areas of Algebra I are reviewed and studied in greater depth. Topics include theorems; operations with rational and irrational expressions; factoring of rational expressions; in-depth study of linear equations and inequalities; quadratic equations; solving systems of linear and quadratic equations; graphing of constant, linear, and quadratic equations; properties of higher degree equations; and operations with rational and irrational exponents. **A graphing calculator is recommended for this class. A TI-84 will be sufficient for this and future math classes. If you are planning to major in engineering or something math related, a TI-Inspire is recommended.** (2 HS credits)

Name of Unit	Time Frame	Essential Learning Target	Standard(s)
Factoring & Solving Quadratics	4 weeks	<p><b>Students can solve quadratic equations.</b></p> <p><b>Students can solve systems of equations</b></p> <p>Students can factor algebraic expressions and polynomials.</p> <p>Students can graph and explain characteristics of a quadratic function.</p> <p>Students can produce equivalent forms of a quadratic function from multiple equations and compare the forms.</p>	<p><i>Seeing Structure in Expressions</i>  <b>A-SSE Write expressions in equivalent forms to solve problems.</b>                      3a. Factor a quadratic expression to reveal the zeros of the function it defines.(A-SSE. 3.) (Essential Standard Algebra 1, Algebra 2)</p> <p>3b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.(A-SSE. 3.) (Essential Standard Algebra 1, Algebra 2)</p> <p><i>Reasoning with Equations &amp;</i></p>

*Inequalities*  
**A-RE I Solve equations and inequalities in one variable.**

3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.(A-REI.3.)  
(Essential Standard Algebra 1, Algebra 2)

4. Solve quadratic equations in one variable.  
(Essential Standard Algebra 1, Algebra 2)

4a. Use the method of completing the square to transform any quadratic equation in  $x$  into an equation of the form  $(x - p)^2 = q$  that has the same solutions. Derive the quadratic formula from this form.(A-REI.4.)  
(Essential Standard Algebra 1, Algebra 2)

4b. Solve quadratic equations by inspection (e.g.,

			<p>for <math>x^2 = 49</math>), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as <math>a \pm bi</math> for real numbers <math>a</math> and <math>b</math>.(A-REI.4.) (Essential Standard Algebra 1, Algebra 2)</p>
Complex Numbers	3 weeks	<p><b>Students can solve a quadratic equation with imaginary solutions.</b></p> <p><b>Students can perform operations with complex numbers.</b></p> <p>Students can simplify, add, subtract, multiply, and divide complex expressions.</p> <p>Students can factor using complex numbers and find imaginary solutions.</p>	<p><b>N-CN.A Perform Arithmetic Operations with Complex Numbers.</b></p> <p><b>N-CN.A.1</b> Know there is a complex number <math>i</math> such that <math>i^2 = -1</math>, and every complex number has the form <math>a + bi</math> with <math>a</math> and <math>b</math> real.</p> <p><b>N-CN.A.2</b> Use the relation <math>i^2 = -1</math> and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.</p> <p><b>N-CN.A.3 (+)</b> Find the conjugate of a</p>

complex number; use conjugates to find moduli and quotients of complex numbers.

**N-CN.B  
Represent  
Complex  
Numbers and  
their operations  
on the Complex  
Number Plane.**

**N-CN.B.5 (+)**

Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. *For example,  $(-1 + \sqrt{3}i)^3 = 8$  because  $(-1 + \sqrt{3}i)$  has modulus 2 and argument  $120^\circ$ .*

**N-CN.C Use  
Complex  
Numbers in  
Polynomial  
Identities and  
Equations**

**N-CN.C.7** Solve quadratic equations with real coefficients that have complex solutions.

**N-CN.C.9 (+)**

Know the Fundamental Theorem of Algebra; show that it is true for quadratic

			polynomials.
Polynomials & Polynomial Functions	5 weeks	<p><b>Students can solve polynomial functions.</b></p> <p>Students can identify and classify multiple types of polynomial functions.</p> <p>Students can find factors and zeros of polynomial functions.</p> <p>Students can divide polynomial functions.</p> <p>Students can use the Conjugate Root Theorem, Rational Root Theorem, and the Fundamental Theorem of Algebra.</p>	<p><i>The Complex Number System</i>  <b>N-CN Use complex numbers in polynomial identities and equations.</b>  7. Solve quadratic equations with real coefficients that have complex solutions.(N-CN. 7.)</p> <p>IA: HS: Algebra  <i>Seeing Structure in Expressions</i>  <b>A-SSE Interpret the structure of expressions.</b></p> <p>1. Interpret expressions that represent a quantity in terms of its context.★</p> <p>1a. Interpret parts of an expression, such as terms, factors, and coefficients.. (A-SSE.1.)</p> <p>2. Use the structure of an expression to identify ways to rewrite it.. (A-SSE.2.)</p> <p><i>Arithmetic with Polynomials &amp; Rational Functions</i>  <b>A-APR Perform arithmetic</b></p>

**operations on polynomials.**

1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.(A-APR.1.)  
(Essential Standard Algebra 1, Algebra 2)

**A-APR  
Understand the relationship between zeros and factors of polynomials.**

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  $p(x)$ .(A-APR.2.)

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.(A-APR.3.)

**A-APR Rewrite rational expressions.**

6. Rewrite simple rational expressions in different forms; write  $\frac{a(x)}{b(x)}$  in the form  $q(x) + \frac{r(x)}{b(x)}$ , 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.(A-APR. 6.)

*Reasoning with Equations & Inequalities*

**A-RE I Represent and solve equations and inequalities graphically.**

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. ★(A-R EI.11.)

IA: HS:  
Functions  
*Interpreting Functions*  
**F-IF Interpret functions that arise in applications in terms of the context.**

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.(F-I F.4.)

5. Relate the

domain of a function to its graph and, where applicable, to the quantitative relationship it describes.(F-IF.5 .)

6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.★(F-IF.6.)

**F-IF Analyze functions using different representations**

.

7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★

7a. Graph linear and quadratic functions and show intercepts, maxima, and minima.(F-IF.7.)

7b. Graph

square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. (F-IF.7.)

7c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. (F-IF.7.)

7d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior. (F-IF.7.)

7e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. (F-IF.7.)

8. Write a function defined by an

expression in different but equivalent forms to reveal and explain different properties of the function.

8a. 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.(F-IF.8.)

8b. Use the properties of exponents to interpret expressions for exponential functions.(F-IF.8.)

9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).(F-IF.9.)

*Building Functions*  
**F-BF Build a function that models a relationship between two quantities.**

			<p>1. Write a function that describes a relationship between two quantities. ★</p> <p><b>F-BF Build new functions from existing functions.</b></p> <p>3. Identify the effect on the graph of replacing <math>f(x)</math> by <math>f(x) + k</math>, <math>k f(x)</math>, <math>f(kx)</math>, and <math>f(x + k)</math> for specific values of <math>k</math> (both positive and negative); find the value of <math>k</math> 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. (F-BF.3.)</p>
<p>Radical Functions &amp; Rational Exponents</p>	<p>5 weeks</p>	<p><b>Students can solve radical equations and check for extraneous solutions.</b></p> <p>Students can simplify radical expressions.</p> <p>Students can simplify expressions with rational exponents.</p> <p>Students can perform function operations.</p>	<p><i>Interpreting Functions</i></p> <p><b>F-IF Analyze functions using different representations</b></p> <p>.</p> <p>7b. Graph square root, cube root, and</p>

piecewise-defined functions, including step functions and absolute value functions.(F-IF.7.)

8b. Use the properties of exponents to interpret expressions for exponential functions.(F-IF.8.)

*Building Functions*  
**F-BF Build a function that models a relationship between two quantities.**

1b. Combine standard function types using arithmetic operations.(F-BF.1.)

1c. (+) Compose functions.(F-BF.1.)

**F-BF Build new functions from existing functions.**

4. Find inverse functions.

4a. 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

			<p>example, <math>f(x) = 2x^3</math> for <math>x &gt; 0</math> or <math>f(x) = (x+1)/(x-1)</math> for <math>x \neq 1</math>.(F-BF.4.)</p> <p>4b. (+) Verify by composition that one function is the inverse of another.(F-BF.4.)</p> <p>4c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.(F-BF.4.)</p> <p>4d. (+) Produce an invertible function from a non-invertible function by restricting the domain.(F-BF.4.)</p>
Exponential & Logarithmic Functions	2 weeks	<p><b>Students can solve exponential and logarithmic equations.</b></p> <p>Students can explore exponential models.</p> <p>Students can use properties of exponential functions.</p> <p>Students can use logarithmic functions as inverses.</p> <p>Students can use properties of logarithms.</p> <p>Students can use natural logarithms to solve equations.</p>	<p><i>Building Functions</i>  <b>F-BF Build new functions from existing functions.</b></p> <p>5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.(F-BF .5.)</p> <p><i>Linear, Quadratic, and</i></p>

*Exponential Models*

**F-LE Construct and compare linear and exponential models and solve problems.**

1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

1a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.(F-LE.1.)

1c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.(F-LE.1.)

3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity

			<p>increasing linearly, quadratically, or (more generally) as a polynomial function.(F-LE.3.)</p> <p>4. For exponential models, express as a logarithm the solution to <math>ab^{ct} = d</math> where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.(F-LE.4.)</p>
<p>Rational Expressions &amp; Equations</p>	<p>2 weeks</p>	<p><b>Students can solve rational equations.</b></p> <p>Students can use inverse variation.</p> <p>Students can use the reciprocal function family.</p> <p>Students can graph rational functions.</p> <p>Students add and subtract rational expressions.</p>	<p><i>Arithmetic with Polynomials &amp; Rational Functions</i></p> <p><b>A-APR Rewrite rational expressions.</b></p> <p>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.(A-APR.7.)</p>

<p>Statistics</p>	<p>2-3 weeks</p>	<p><b>Students can calculate probability, graph and analyze data.</b></p> <p>Students can calculate permutations and combinations.</p> <p>Students can find the probability of a singular, independent event.</p> <p>Students can find the probability of multiple events.</p> <p>Students can find conditional probability.</p> <p>Students can calculate measures of central tendency.</p> <p>Students can analyze a data set.</p>	<p><b>S-ID.A.1</b>  Represent data with plots on the real number line (dot plots, histograms, and box plots).</p> <p><b>S-ID.A.2</b> Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.</p> <p><b>S-ID.A.3</b>  Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).</p> <p><b>S-IC.A.2</b> Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. <i>For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the</i></p>
-------------------	------------------	--	---

*model?*

**S-CP.A.2**

Understand that two events  $A$  and  $B$  are independent if the probability of  $A$  and  $B$  occurring together is the product of their probabilities, and use this characterization to determine if they are independent.

**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 saying that the conditional probability of  $A$  given  $B$  is the same as the probability of  $A$ , and the conditional probability of  $B$  given  $A$  is the same as the probability of  $B$ .

**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 approximate conditional probabilities. *For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*

**S-CP.A.5**

Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. *For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.*

**S-CP.B.9 (+)**

			Use permutations and combinations to compute probabilities of compound events and solve problems.
Matrices	2 weeks	<p><b>Students can perform operations with matrices.</b></p> <p>Students can add and subtract matrices.</p> <p>Students can multiply matrices.</p>	<p><b>N-VM.C.6</b> (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.</p> <p><b>N-VM.C.7</b> (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.</p> <p><b>N-VM.C.8</b> (+) Add, subtract, and multiply matrices of appropriate dimensions.</p> <p><b>N-VM.C.9</b> (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.</p> <p><b>N-VM.C.10</b></p>

			<p>(+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.</p>
--	--	--	---