Algebra II Mathematics Curriculum Guide

Grade Level/Course Title: Algebra II	**Quarter 1**	**Academic Year: 2016-2017**

Mathematics Focus for the Course:
For the high school Model Algebra II course, instructional time should focus on four critical areas: (1) relate arithmetic of rational expressions to arithmetic of rational numbers; (2) expand understandings of functions and graphing to include trigonometric functions; (3) synthesize and generalize functions and extend understanding of exponential functions to logarithmic functions; and (4) relate data display and summary statistics to probability and explore a variety of data collection methods.

Essential Questions for this Unit:

1. How can students develop fluency writing, interpreting, and translating among various forms of linear equations and inequalities, and use them to solve problems?
2. How can students interpret functions given graphically, numerically, symbolically, and verbally; translate between representations?
3. How can students explore systems of equations and find and interpret their solutions?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 1: (August-September) **Linear and Absolute Value Equations, Functions and Graphs (Algebra 1 Review)** **25 total days** **(+): add 1 day**	A-CED.1	Create equations and inequalities in one variable **including ones with absolute value** and use them to solve problems. **CA**	• Proper Syntax Syntax (GMR) • Academic Vocabulary • Equivalent form of one • Equivalent form of zero • Inverse operations • Distributing with a negative • Procedural fluency and flexibility • Build on multiple-methods for solving equations • Real world contexts	**** O1.2 means suggested Objective 2 from Unit 1. Each objective should be taught for 1 day, unless otherwise specified. "1 day" is one 55-minute period. Any objective listed with (+) is "advanced" and "nice to have".** O1.1 Interpret parts of an expression, such as terms, factors, and coefficients. View one or more parts of a complicated expression as a single entity. O1.2: Create and solve equations in one-variable, including equations with coefficients represented by letters. **(2 days)** Performance Task—How Does the Solution Change? (IMT) Solving Equations with Variables on Both Sides (L) Performance Task—Equations and Formulas (IMT) O1.3: Create and solve one-variable inequalities. O1.4: Solve one-variable absolute value equations. O1.5: Solve one-variable absolute value inequalities. Absolute Value Equations & Inequalities (CP) **Review and Quiz (1 day)**
	A-REI.3 (Algebra 1 standard)	Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.		
	A-REI.3.1	**Solve one-variable equations and inequalities involving absolute value, graphing the solutions and interpreting them in context. CA**		
	A-SSE.1	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.		

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Essential Questions for this Unit:
1. How can students develop fluency writing, interpreting, and translating among various forms of linear equations and inequalities, and use them to solve problems?
2. How can students interpret functions given graphically, numerically, symbolically, and verbally; translate between representations?
3. How can students explore systems of equations and find and interpret their solutions?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 1 continued: (August-September) **Linear and Absolute Value Equations, Functions and Graphs (Algebra 1 Review)** **25 total days** **(+): add 1 day**	A-CED.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.★	• Function notation • Function values • Mastery of graphing linear functions • Family of linear functions Family of Functions Graphing Worksheet (GMR) • Key features of function graphs • Increasing vs. decreasing given an interval • Rate of change is a constant in linear functions • Different methods of interval description e.g. $3 \le x < 5$ or [3, 5)	O1.6: Graph linear situations using a table of values. Performance Task—Writing Constraints (IMT) O1.7: Identify key features of linear functions given a graph or a table. (Domain, Range, Intercepts, Increasing/Decreasing on intervals, Average rate of change) Average Rate of Change (pg 2–6) (L) Performance Task—Temperature Change (IMT) Performance Task—Laptop Battery Charge (IMT) O1.8: Create a table and graph from functional notation. Graphing Family of Functions (L) Key Curriculum: 4.3 O1.9: Graph linear equations in slope-intercept form (in function notation). Slope Intercept Sort (L) O1.10: Compare key features of 2 linear functions each represented in a different way. Comparing Linear and Quadratic Functions (L) modify so that you are comparing 2 linear functions
	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. ★		
	F-IF.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.9	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in table, or by verbal descriptions).		
	F-BF.3	Identify the effect on the graph of replacing *f(x)* by *f(x) + k, kf(x), f(kx),* and *f(x + k)* for specific values of *k* (both positive and negative); find the value of *k* given the graphs. (Use technology.)		
	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.		

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Mathematics Focus for the Course:
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Essential Questions for this Unit:
1. How can students develop fluency writing, interpreting, and translating among various forms of linear equations and inequalities, and use them to solve problems?
2. How can students interpret functions given graphically, numerically, symbolically, and verbally; translate between representations?
3. How can students explore systems of equations and find and interpret their solutions?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 1 continued: (September) **Linear and Absolute Value Equations, Functions and Graphs (Algebra 1 Review)** **25 total days** **(+): add 1 day**	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.	• Finding the inverse of a linear function given: a table, a graph, or an algebraic representation • A function and its inverse has an axis of symmetry at *y = x* • Solution to linear inequalities as a half-plane • Mastery of graphing absolute value functions • Understanding of the general shape of absolute value functions • Function notation • Family of absolute value functions Family of Functions Graphing Worksheet (GMR)	O1.11: Find the inverse of linear functions given a table, graph, or rule. Inverse Functions (L) Key Curriculum: 5.5 (linear only) O1.12: Graph linear inequalities from slope-intercept form. Graphing Linear Inequalities Sort (L) Performance Task—Fishing Adventures (IMT) O1.13: Graph absolute value functions using a table. **Emphasize function notation and finding the *x*- and *y*-intercepts. This is emphasized in subsequent units for most functions. O1.14: Sketch transformations of absolute value functions (include shifts left, right, up, down). Identify values where $f(x) = g(x)$ on linear/absolute value systems. Connecting Graphing & Solving Absolute Value Functions (pg 3&4) (L) O1.15(+): Sketch transformations of absolute value functions (include dilations and reflections). Key Curriculum: 4.6 O1.16: Derive the point-slope form of linear equations and write equations from a context. (given data point and slope AND given two data points) Point-Slope Application Problems (L) **Review and Quiz (1 day)**
	F-BF.4	Find inverse functions.		
	A-REI.12 Algebra 1 standard	Graph solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality).		
	F-IF.7.b	Graph (absolute value) functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.		
	F-BF.3	Identify the effect on the graph of replacing *f(x)* by *f(x) + k, kf(x), f(kx),* and *f(x + k)* for specific values of *k* (both positive and negative); find the value of *k* given the graphs. (Use technology.)		

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Essential Questions for this Unit:
1. How can students develop fluency writing, interpreting, and translating among various forms of linear equations and inequalities, and use them to solve problems?
2. How can students interpret functions given graphically, numerically, symbolically, and verbally; translate between representations?
3. How can students explore systems of equations and find and interpret their solutions?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 1 continued: (September) **Linear and Absolute Value Equations, Functions and Graphs (Algebra 1 Review)** **25 total days** **(+): add 1 day**	A-CED.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. ★	• Finding and interpreting the average rate of change (slope) of a linear equation • Interpreting point-slope form of a linear function • Connection between the solution to a system and the graph of that system • Possible outcomes of solving a system: infinitely many, no, one solution • Systems within a real-world context • Piecewise-defined functions within a real-world context	O1.17: Use context problems to graph systems of linear equations and interpret their solution(s). Key Curriculum: 3.6 O1.18: Use context problems to solve systems of linear equations by substitution. Key Curriculum: 3.6 Performance Task—Dimes and Quarters (IMT) Performance Task—Growing Coffee (IMT) O1.19: Graph piecewise-defined functions using graphing knowledge of linear equations and absolute value equations. **Use context problems **(2 days)** Graphing Piecewise Functions (linear only) (L) Performance Task—Pizza Place Promotion (IMT) Performance Task—Bank Account Balance (IMT) **End of Unit 1. Review, Assess, Reteach (3 days)**
	F-BF.1	Write a function that describes a relationship between two quantities. ★		
	A-REI.6 (Algebra 1 standard)	Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.		
	F-IF.7b	Graph (piecewise) functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.		

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Grade Level/Course Title: Algebra II	**Quarter 1-2**	**Academic Year: 2016-2017**

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Essential Questions for this Unit:

1. How can students focus on quadratic functions; interpret functions given graphically, numerically, symbolically, and verbally; translate between representations and understand the limitations of various representations?
2. How can students learn to anticipate the graph of a quadratic function by interpreting various forms of quadratic expressions, and in particular, identify the real and complex solutions of quadratic equations and recognize the real solutions as the zeros of a related quadratic function?
3. How can students synthesize and generalize what they have learned about a variety of function families?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 2: (Oct – beg. Nov) **Quadratic Equations, Functions and Graphs** **21 total days (+): add 1 day**	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 of quadratic functions Function notation Evaluating functions given a rule and a graph Find and interpret the average rate of change over an interval Average rate of change of a linear function (slope) vs. average rate of change of a quadratic function Graphing from a table Difference bet. -3^2 and $(-3)^2$ Family of quadratic functions Family of Functions Graphing Worksheet (GMR) Vertex form	O2.1: Identify key features of quadratic functions given a graph or table. Sketch graphs showing key features given a verbal description. (Evaluate input/output of graphed function, Domain, Range, Intercepts, Increasing/Decreasing on intervals, Maximum/Minimum values (vertex), Axis of symmetry, Concave up/down) Key Features of Graphs (quadratics only) (L) Performance Task—Graphing Stories (IMT) Performance Task—Throwing Baseballs (IMT) Performance Task—Warming and Cooling (IMT) O2.2: Find the average rate of change over an interval given a quadratic graph or rule. Average Rate of Change (pg 7–10) (L) Performance Task—Mathemafish Population (IMT) O2.3: Compare the average rate of change of quadratics to the average rate of change of linear functions. Comparing Linear and Quadratic Functions (L) O2.4 Graph quadratic functions using a table. Include the parent function, its opposite, and $f(x)+k$. Emphasize functional notation evaluation. O2.5: Sketch transformations $f(x)=(x-h)^2+k$ given the parent function $f(x)=x^2$. Write a quadratic rule given its graph. Key Curriculum: 4.4 Exploring Quadratic Graphs (L)
	F-IF.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.9	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).		
	F-BF.3	Identify the effect on the graph of replacing *f(x)* by *f(x) + k, kf(x), f(kx),* and *f(x + k)* for specific values of *k*; find the value of *k* given the graphs. (Use technology.)		
	F-IF.7a (Alg 1)	Graph linear and quadratic functions and show intercepts, maxima, and minima.		

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Essential Questions for this Unit:

1. How can students focus on quadratic functions; interpret functions given graphically, numerically, symbolically, and verbally; translate between representations and understand the limitations of various representations?
2. How can students learn to anticipate the graph of a quadratic function by interpreting various forms of quadratic expressions, and in particular, identify the real and complex solutions of quadratic equations and recognize the real solutions as the zeros of a related quadratic function?
3. How can students synthesize and generalize what they have learned about a variety of function families?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 2 continued: (Oct – beg. Nov) **Quadratic Equations, Functions and Graphs** **21 total days (+): add 1 day**	A-REI.4b (Algebra 1)	Solve quadratic equations by inspection (e.g., for $x^2 = 49$), 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 $a+bi$ for real numbers *a* and *b*.	• Sketch a quadratic function with roots, *y*-intercept, and concavity. • Zero Product Property • Properties of *i* • Arithmetic with the complex numbers • Complex vs. real roots and its graphed relationship • Solving quadratic equations using an appropriate method • Vertex form	O2.6 Rewrite polynomial expressions into equivalent forms, including multiplying polynomials, factoring the GCF, trinomial factoring, factoring by grouping, difference of two squares (All Alg 1 review). O2.7: Factor to find *x*-intercepts/roots/zeros of quadratic functions. **(3 days)** Quadratics – Matching Game (L) Performance Task—Equivalent Expressions (IMT) Performance Task—Zero Product Property (IMT) O2.8: Determine what is revealed given different forms of a quadratic equation (vertex, standard, factored forms). Convert algebraically between forms. Performance Task—Graphs of Quadratic Functions (IMT) Performance Task—Which Function? (IMT) **---- End of Algebra 1 Review ----** O2.9: Investigate the complex numbers. Arithmetic with complex numbers. **(2 days)** Key Curriculum: 7.5 Performance Task—Computations with Complex Numbers (IMT) O2.10: Find the roots of quadratic functions using the Quadratic Formula. **Include real and imaginary roots **(2 days)** Key Curriculum: 7.4 Performance Task—Rewriting a Quadratic Expression (IMT)
	F-IF.8	Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.		
	A-SSE.2	Use the structure of an expression to identify ways to rewrite it.		
	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.		
	N-CN.2	Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.		
	N-CN.7	Solve quadratic equations with real coefficients that have complex solutions.		

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2. How can students learn to anticipate the graph of a quadratic function by interpreting various forms of quadratic expressions, and in particular, identify the real and complex solutions of quadratic equations and recognize the real solutions as the zeros of a related quadratic function?
3. How can students synthesize and generalize what they have learned about a variety of function families?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 2 continued: (Oct – beg. Nov) **Quadratic Equations, Functions and Graphs** **21 total days** **(+): add 1 day**	G-GPE.3.1	Given a quadratic equation of the form $ax^2 + by^2 + cx + dy + e = 0$, use the method for completing the square to put the equation into standard form; identify whether the graph of the equation is a circle, ellipse, parabola, or hyperbola, and graph the equation. **[In Algebra II, this standard addresses circles and parabolas only.] CA**	• Piecewise functions as a spiraling activity • Inverse of $f(x) = x^2$-1 and other simple quadratics as square root functions. • Use graphing calculators to visualize quadratic functions and their inverses as reflections over the line $y = x$.	O2.11: Find the roots of quadratics by completing the square. **Include real and imaginary roots Review how to solve a quadratic equation using square roots as a scaffolding activity. **(2 days)** Key Curriculum: 7.3 Performance Task—Vertex of a Parabola with Complex Roots (IMT) Performance Task—Two Squares are Equal (IMT) Performance Task—Visualizing Completing the Square (IMT) O2.12: Given a quadratic equation of the form $ax^2 + by^2 + cx + dy + e = 0$, use the method for completing the square to put the equation into standard form**.** Identify this equation as a circle when graphed. O2.13: Graph piecewise-defined functions using graphing knowledge of linear and quadratic functions. O2.14(+): Find the inverse of quadratic functions. Use technology to graph quadratics and their inverses. Performance Task—Braking Distance (IMT) Performance Task—Springboard Dive (IMT) **End of Unit 2. Review, Assess, Reteach (3 days)** **Benchmark 1 will include Units 1 and 2.**
	A-SSE.3 (Alg 1)	a. Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum of minimum value of the function it defines.		
	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.		
	F-IF.7b	Graph (piecewise) functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.		

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Essential Questions for this Unit:
1. How can students identify zeros of polynomials, including complex zeros of quadratic polynomials, and make connections between zeros of polynomials and solutions of polynomial equations?
2. How can students examine The Fundamental Theorem of Algebra?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 3: (Nov. – Dec) **Polynomial Equations, Functions and Graphs** **13 total days**	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 of polynomial functions • Domain, range, end behavior, odd vs. even functions • Zeros, roots, *x*-intercepts • Fundamental Theorem of Algebra • Multiplicity of zeros as it applies to the graph of a polynomial function • Factors vs. Zeros/roots/ *x*-intercepts • Greatest Common Factor (GCF) • Completely factoring quartics without cubic or linear terms (ex. x^4-1, or x^4+3x^2-4)	Performance Task—Non-Negative Polynomials (IMT) Performance Task—Powers of 11 (IMT) O3.1: Identify the key features of the graphs of polynomials with degree greater than two. (Evaluate input/output of graphed function, general shape of the graph, odd/even graphs, end behavior, max number of potential zeros (given the degree)) **(2 days)** O3.2: Identify the zeros of a polynomial given its graph and given a function in factored form. Key Curriculum: 7.7 O3.3: Given a factored polynomial identify its zeros and match or sketch its potential graph (and vice versa). Key Curriculum: 7.7 Performance Task—Graphing From Factors I (IMT) Performance Task—Graphing From Factors II (IMT) O3.4: Given the graph of a polynomial, write a potential factored polynomial function based on its zeros. Key Curriculum: 7.7
	F-BF.3	Recognize even and odd functions from their graphs and algebraic expressions for them.		
	F-IF.7c	Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. ★		
	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.		

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Essential Questions for this Unit:
1. How can students identify zeros of polynomials, including complex zeros of quadratic polynomials, and make connections between zeros of polynomials and solutions of polynomial equations?
2. How can students examine The Fundamental Theorem of Algebra?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 3 continued: (Nov. – Dec) **Polynomial Equations, Functions and Graphs** **13 total days**	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 $p(x)$.	• The Remainder Theorem: if you divide polynomial $p(x)$ by $(x – a)$ and get a remainder of zero, then a is a root of $p(x)$ • Evaluating a function for n vs. dividing it by a factor of $(x – n)$ • Mathematical meaning of division • Polynomial long division • Synthetic division and its connection to evaluation AND long division • Comparing multiple-methods for finding zero of a polynomial function	O3.5: Factor cubics with a GCF that includes x (once GCF is factored, they will be quadratics) to find zeros. Performance Task—Solving a Simple Cubic Equation (IMT) O3.6: Factor special quartics to find zeros. O3.7: Use polynomial long division to determine if $x - a$ is a factor of a given polynomial (Remainder Theorem application). Polynomial Division (L) O3.8: Use synthetic division to determine if $x - a$ is a factor of a given polynomial (Remainder Theorem application). O3.9: Perform side by side comparisons of long division, synthetic division, and evaluating a polynomial to find its zeros. **(2 days)** Key Curriculum: 7.8 Performance Task—Graphing From Factors (IMT) Performance Task—The Missing Coefficient (IMT) **End of Unit 3.** **Review, Assess, Reteach (3 days)** **Should finish Unit 3 before December break.**
	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.		

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Essential Questions for this Unit:

1. How can students learn about the concept that is the central theme of the Model Algebra II course, that the arithmetic of rational expressions is governed by the same rules as the arithmetic of rational numbers?
2. Building on their work with linear and quadratic functions, how can students extend their repertoire of functions to include rational functions?
3. How can students synthesize and generalize what they have learned about a variety of function families?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 4: (January) **Rational Equations, Functions and Graphs** **12 days**	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.	• Simplifying, multiplying, and dividing fractions • Adding and subtracting fractions with like and unlike denominators • Factoring quadratics • Factoring with the GCF • Extraneous roots	****According to CCSS Math Appendix A, "in this course rational functions are limited to those whose numerators are of degree at most 1 and denominators of degree at most 2."** O4.1: Simplify rational expressions by factoring and long division **(2 days)** Rational Functions (L) Key Curriculum: 9.8 (select problems only) O4.2: Multiply and divide rational expressions. **(2 days)** Key Curriculum: 9.8 (select problems only) O4.3: Add and subtract rational expressions with a monomial denominator. O4.4: Add and subtract rational expressions with a binomial denominator. Key Curriculum: 9.8 (select problems only) Performance Task--Reasoning With Linear Inequalities (IMT) O4.5: Solve rational equations in one variable and identify extraneous roots. **(2 days)** Performance Task--Basketball (IMT) Performance Task—Ideal Gas Law (IMT) O4.6: Find inverse functions. (e.g. $f(x) = (x+1)/(x-1)\ for\ x \neq 1$) **End of Unit 4. Review, Assess, Reteach (3 days)**
	A-REI.2	Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.		
	A-APR.7	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.		
	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.		

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Grade Level/Course Title: Algebra II	**Quarter 3**	**Academic Year: 2016-2017**

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Essential Questions for this Unit:
1. Building on their work with linear and quadratic functions, how can students extend their repertoire of functions to include radical functions?
2. How can students synthesize and generalize what they have learned about a variety of function families?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 5: (Jan – beg. Feb) **Radical Equations, Functions and Graphs** **12 total days**	F-IF.7b	Graph (square root and cube root) functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.	• Square and cube roots • Applications of radical functions • Key features of the graphs of radical functions • From a graph, estimate input values given an output AND output values given an input • Finding and interpreting average rate of change over an interval • Simplifying radicals • Solving radical equations • Linear functions vs. radical functions	O5.1 Rewrite expressions involving integer exponents using the properties of exponents. O5.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents, including conversion between both forms. O5.3: Solve radical equations in one variable, including ones with extraneous roots. Rewrite formulas to solve for a specific variable. Performance Task—Radical Equations (IMT) O5.4: Graph simple square and cube root functions. Transform radical functions given the parent function $f(x)=\sqrt{x}$ and $f(x)=\sqrt[3]{x}$. Write a radical function given its graph. Key Curriculum: 4.5 (square roots only) O5.5: Relate applications of radical functions to their graphs. Identify key features from the graph, including estimating input values given an output and estimating output values given an input. O5.6: Given a radical function and its input value, find its output. Given a radical function and its output value, find its input. (Different from O5.4 because these are exact values found by solving the equation.)
	F-BF.3	Identify the effect on the graph of replacing *f(x)* by *f(x) + k, kf(x), f(kx),* and *f(x + k)* for specific values of *k* (both positive and negative); find the value of *k* given the graphs. (Use technology.)		
	N-RN.1 (Algebra 1 standard)	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.		
	N-RN.2 (Algebra 1 standard)	Rewrite expressions involving radicals and rational exponents using the properties of exponents.		
	A-REI.2	Solve simple ~~rational and~~ radical equations in one variable, and give examples showing how extraneous solutions may arise.		

Algebra II Mathematics Curriculum Guide

Grade Level/Course Title: Algebra II	**Quarter 3**	**Academic Year: 2016-2017**

Mathematics Focus for the Course:
For the high school Model Algebra II course, instructional time should focus on four critical areas: (1) relate arithmetic of rational expressions to arithmetic of rational numbers; (2) expand understandings of functions and graphing to include trigonometric functions; (3) synthesize and generalize functions and extend understanding of exponential functions to logarithmic functions; and (4) relate data display and summary statistics to probability and explore a variety of data collection methods.

Essential Questions for this Unit:
1. Building on their work with linear and quadratic functions, how can students extend their repertoire of functions to include radical functions?
2. How can students synthesize and generalize what they have learned about a variety of function families?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 5 continued: (Jan – beg. Feb) **Radical Equations, Functions and Graphs** **12 total days**	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.	• Inverse functions • Explain why the inverse of a square root function is a quadratic function • Fluency with transforming piecewise-defined functions between two representations (symbolic and graphic)	O5.7: Find average rate of change over a given interval given both rules and graphs; find inverse functions. (spiraling activity) O5.8: Given a radical function $f(x)$ and a linear function $g(x)$, either in rule or graph form, find the intersection of the system [point where $f(x) = g(x)$]. O5.9: Graph a piecewise function given symbolically. Write a piecewise function given its graph. **Good spiraling activity. **End of Unit 5.** **Review, Assess, Reteach (3 days)** **<u>Benchmark 2 will include Units 3, 4, and 5.</u>** **Should finish Unit 5 before February break.**
	F-IF.7b	Graph (piecewise) functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.		
	F-IF.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.		

Algebra II Mathematics Curriculum Guide

Grade Level/Course Title: Algebra II	**Quarter 3**	**Academic Year: 2016-2017**

Mathematics Focus for the Course:
For the high school Model Algebra II course, instructional time should focus on four critical areas: (1) relate arithmetic of rational expressions to arithmetic of rational numbers; (2) expand understandings of functions and graphing to include trigonometric functions; (3) synthesize and generalize functions and extend understanding of exponential functions to logarithmic functions; and (4) relate data display and summary statistics to probability and explore a variety of data collection methods.

Essential Questions for this Unit:
1. Building on their work with linear and quadratic functions, how can students extend their repertoire of functions to include exponential and logarithmic functions?
2. How can students extend their work with exponential functions to include solving exponential equations with logarithms?
3. How can students identify appropriate types of functions to model a situation, adjust parameters to improve the model, and compare models by analyzing appropriateness of fit and making judgments about the domain over which a model is a good fit?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 6: (end Feb – beg. March) **Exponential and Logarithmic Equations, Functions and Graphs** **16 total days** **(+): add 1 day**	F-IF.7e	Graph exponential and logarithmic functions, showing intercepts and end behavior.	• Model exponential growth and decay • Linear vs. exponential functions • Finding and interpreting average rate of change over a given interval • Changing exponential equations to have equivalent bases • Logarithm definition • Function values for a logarithmic function • Contextual problems • General form of an exponential function $f(t)=a(1+r)^t$ where *a* is the initial condition, *r* is the rate, and *t* is the time. • Doubling is 100% + 100% = 200%= 2	O6.1: Review properties of exponents, including changing fractional exponents to it's radical equivalent and simplifying when possible. Roots and Fractional Exponents (L) O6.2: Find an exponential pattern in an activity, draw its graph, and write its equation. Writing Exponential Functions Based on Data: An Introductory Lesson (L) O6.3: Compare exponential vs. linear functions by comparing output patterns and differences in average rate of change. O6.4: Write an exponential equation given a context and solve for the exponential variable by creating equivalent bases. Key Curr: 5.2 Solving Exponential Equations (L) O6.5: Write an exponential equation given percent growth rate. O6.6: Use the properties of logarithms to simplify logarithmic numeric expressions; identify their approximate values. O6.7: Change exponent equations to logarithmic equations and vice versa. Use the power property of logs to rewrite logarithmic equations. Introduction to Logarithms (L) Performance Task—Rewriting Equations (IMT) Performance Task—Population and Food Supply (IMT)
	F-IF.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.		
	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.*		
	F-LE.4.3	**Understand and use the properties of logarithms to simplify logarithmic numeric expressions and to identify their approximate values. CA ★**		
	F-LE.4	For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where *a*, *c*, and *d* are numbers and the base *b* is 2, 10, or *e*; evaluate the logarithm using technology. ★ [Logarithms as solutions for exponentials.]		
	F-LE.4.1	**Prove simple laws of logarithms. CA ★** (Power Property)		

Grade Level/Course Title: Algebra II	**Quarter 3**	**Academic Year: 2016-2017**

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Essential Questions for this Unit:
1. Building on their work with linear and quadratic functions, how can students extend their repertoire of functions to include exponential and logarithmic functions?
2. How can students extend their work with exponential functions to include solving exponential equations with logarithms?
3. How can students identify appropriate types of functions to model a situation, adjust parameters to improve the model, and compare models by analyzing appropriateness of fit and making judgments about the domain over which a model is a good fit?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 6 continued: (end Feb – beg. March) **Exponential and Logarithmic Equations, Functions and Graphs** **16 total days**	F-IF.7e	Graph exponential and logarithmic functions, showing intercepts and end behavior.	• Key features of an exponential function (asymptote) • Key features of logarithmic functions • Family of exponential functions • Family of logarithmic functions Family of Functions Graphing Worksheet (GMR) • Exponential and logarithmic functions as inverses • Solve equations involving the natural logarithm, *e* • Fluency with transforming piecewise-defined functions between two representations (symbolic and graphic)	O6.8: Express as a logarithmic algorithm the solution to contextual problems that use $ab^{ct} = d$. Evaluate this logarithm using technology. **(up to 2 days)** O6.9: Sketch graphs of exponential and logarithmic functions using knowledge of transformation rules. Describe the end behavior of exponential and logarithmic graphs. (ex. $f(x) = 2^{x+1} - 4$) **(2 days)** Average Rate of Change (pg 10–12) (L) Performance Task—Identifying Exponential Functions (IMT) Performance Task—Exponential Kiss (IMT) Performance Task—Carbon-14 Dating in Practice (IMT) O6.10(+): Find the inverse of an exponential function. (e.g. inverse of $f(x) = 3^{x+1}$) Use the change of base property. O6.11: Define the natural logarithm *e* and use it to solve problems. Interest and the Number e (L) Performance Task—Forms of Exponential Expressions (IMT) Performance Task—Identifying Graphs of Functions (IMT) O6.12: Graph a piecewise function given symbolically. Write a piecewise function given its graph. **Good spiraling activity.
	F-BF.4	Find inverse functions.		
	F-LE.4	For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where *a*, *c*, and *d* are numbers and the base *b* is 2, 10, or *e*; evaluate the logarithm using technology. ★ [Logarithms as solutions for exponentials.]		
	F-IF.7b	Graph (piecewise) functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.		

(+): add 1 day				**End of Unit 6. Review, Assess, Reteach (3 days)**

Grade Level/Course Title: Algebra II	**Quarter 4**	**Academic Year: 2016-2017**

Mathematics Focus for the Course:
For the high school Model Algebra II course, instructional time should focus on four critical areas: (1) relate arithmetic of rational expressions to arithmetic of rational numbers; (2) expand understandings of functions and graphing to include trigonometric functions; (3) synthesize and generalize functions and extend understanding of exponential functions to logarithmic functions; and (4) relate data display and summary statistics to probability and explore a variety of data collection methods.

Essential Questions for this Unit:
1. Building on their work with functions previously studied in Algebra II, how can students extend their repertoire of functions to include trigonometric functions?
2. How can students build on their previous work with functions and on their work with trigonometric ratios and circles in the Model Geometry course, now use the coordinate plane to extend trigonometry to model periodic phenomena?
3. How can students synthesize and generalize what they have learned about a variety of function families?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 7: **(March – April)** **Trigonometric Equations, Functions and Graphs**	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.	• Standard position of an angle • Negative, coterminal and reference angle • Initial and Terminals sides • Find coordinates of key points on the unit circle and relate them to sine and cosine • Special right triangle	**** An alternative layout for this unit is to introduce radians at the beginning and use radians & degrees interchangeably** O7.1: Convert degrees to radians and vice versa. Define and find coterminal and reference angles on the standard position given both positive and negative degrees. O7.2: Define unit circle in terms of degrees and radians. Sketch an angle in both degrees and radians on the unit circle. Include negative and coterminal angles. O7.3: Review special right triangles, identify their sine and cosine values, and identify key reference angles of 30/45/60 and $\frac{p}{6}, \frac{p}{4}, \frac{p}{3}$ on
	F-TF.3	(+) Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosine, and tangent for π–*x*, π+*x*, and 2π–*x* in terms of their values for *x*, where *x* is any real number.		

17 total days **(+): add 4 days**	F-TF.1	Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.	properties (30-60-90 and 45-45-90) • SOH CAH TOA • (+) Defining reciprocal functions: csc, sec, cot • Arc length • Radian measure	the unit circle. Include 0º, 90º, 180º, 270º, 360º. O7.4: Find exact values of sine or cosine for a given angle by sketching, determining the reference angle, then using special right triangle properties to determine key coordinates on a unit circle. **(2 days)** O7.5: (+): Define and find exact values of the reciprocal functions cosecant, secant, and cotangent for special arguments in both radians and degrees. **Review and Quiz (1 day)**

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Essential Questions for this Unit:
1. Building on their work with functions previously studied in Algebra II, how can students extend their repertoire of functions to include trigonometric functions?
2. How can students build on their previous work with functions and on their work with trigonometric ratios and circles in the Model Geometry course, now use the coordinate plane to extend trigonometry to model periodic phenomena?
3. How can students synthesize and generalize what they have learned about a variety of function families?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 7 continued: (March – April) **Trigonometric Equations,**	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.	• Fluency with computing degrees from radians and radians from degrees • Coordinates of key points on the unit circle (in radians) • Graphs of trigonometric functions • Define and interpret periodicity	Performance Task—Model Airplane Acrobatics (IMT) O7.6(+): Identify key features, find the average rate of change over an interval on trigonometric graphs and find values where $f(x)=g(x)$ on such graphed systems. O7.7: Graph $f(x)$ = sin$x$, $f(x)$ = cos$x$, $f(x)$ = tan$x$ and their reciprocals. **(2 days)**
	F-TF.2.1	**Graph all 6 basic trigonometric functions. CA**		
	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. ★		

Functions and Graphs **17 total days** **(+): add 4 days**	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.	• Key features of trigonometric functions (amplitude, period, midline, and end behavior) • Find and interpret average rate of change • Family of trigonometric functions • Why could a graph be BOTH a graph of sine and a graph of cosine?	O7.8: Graph transformations of trigonometric functions. Address the general form $f(x) = A \times \sin(Bx - C) + D$ (and cosine function) as it relates to amplitude, frequency midline, and horizontal shifts. **(2 days)** Key Curriculum: 10.3 O7.9: Write a trigonometric function given its graph. **Why could a graph be BOTH a graph of sine and a graph of cosine?
	F-IF.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-BF.3	Identify the effect on the graph of replacing *f(x)* by *f(x) + k, kf(x), f(kx),* and *f(x + k)* for specific values of *k* (both positive and negative); find the value of *k* given the graphs. (Use technology.)		

Grade Level/Course Title: Algebra II	**Quarter 4**	**Academic Year: 2016-2017**

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Essential Questions for this Unit:
1. Building on their work with functions previously studied in Algebra II, how can students extend their repertoire of functions to include trigonometric functions?
2. How can students build on their previous work with functions and on their work with trigonometric ratios and circles in the Model Geometry course, now use the coordinate plane to extend trigonometry to model periodic phenomena?
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Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 7 continued: (March – April) **Trigonometric**	F-TF.5	Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline. ★	• Context problems for trigonometric functions • (+) Graphs of reciprocal trig functions • (+) Key features of reciprocal trig functions • (+) Transformations of	O7.10: Model periodic phenomena with trigonometric functions. Key Curriculum: 10.5 Performance Task—Analyzing Graphs (IMT) O7.11: Prove the Pythagorean identity $\sin^2 q + \cos^2 q = 1$ and use it to find $\sin q$, $\cos q$, or $\tan q$ given $\sin q$, $\cos q$, or $\tan q$ and the quadrant of the angle. **(2 days)** Key Curriculum: 10.6
	F-TF.2.1	**Graph all 6 basic trigonometric functions. CA**		
	F-TF.8	Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.		

Equations, Functions and Graphs **17 total days** **(+): add 4 days**	F-TF.9	(+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.	reciprocal trig functions • Verify trigonometric identities	O7.12(+): Prove and apply the addition and subtraction formulas for trigonometric functions. Key Curriculum: 10.7 O7.13(+): Prove and apply the half angle and double angle identities for trigonometric functions. Key Curriculum: 10.7 **End of Unit 7.** **Review, Assess, Reteach (3 days)**
	F-TF.10	**(+) Prove the half angle and double angle identities for sine and cosine and use them to solve problems. CA**		

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Essential Questions for this Unit:
1. How can students see how the visual displays and summary statistics they learned in earlier grades relate to different types of data and to probability distributions.
2. How can students identify different ways of collecting data—including sample surveys, experiments, and simulations—and the role that randomness and careful design play in the conclusions that can be drawn.

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 8: **(May)**	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.	Summarize, represent, and interpret data on a single count or measurement variable. While students may have heard of the normal distribution, it is unlikely that they will have prior experience using it to make specific estimates. Build on students'	**See Illuminate Item Bank for sample problems. O8.1: Find the mean and standard deviations given a data set and relate them to a graph of normal distribution (bell curve). Estimate a population percentage given such a graph. O8.2: Find the mean and standard deviations given a data

Statistics and Probability **20 days**	S-IC.1	Understand statistics as a process for making inferences about population parameters based on a random sample from that population.	understanding of data distributions to help them see how the normal distribution uses area to make estimates of frequencies (which can be expressed as probabilities). Emphasize that only some data are well described by a normal distribution. Understand and evaluate random processes underlying statistical experiments. For S.IC.2, include comparing theoretical and empirical results to evaluate the effectiveness of a treatment.	set, context and/or a graph. O8.3: Estimate population percentages, given a mean and/or standard deviation of a normally distributed data set. O8.4: Describe criteria needed for a statistically viable random sample surveys and its rationale. (biases, representative sample and sample size, randomization processes and potential inherent biases in the biases) O8.5: Given a context, determine if a survey method and its results is viable enough to make inferences about the population in general. O8.6: Decide if a specified model is consistent with results from a given data-generating process. **Review and Quiz (2 days)**
	S-IC.2	Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. 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 model?		

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Essential Questions for this Unit:
1. How can students see how the visual displays and summary statistics they learned in earlier grades relate to different types of data and to probability distributions?
2. How can students identify different ways of collecting data—including sample surveys, experiments, and simulations—and the role that randomness and careful design play in the conclusions that can be drawn?

Unit (Time)	Standard	Standard Description	Content	Objectives and Resources
Unit 8 continued: (May)	S-IC.3	Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.	Make inferences and justify conclusions from sample surveys, experiments, and observational studies. In earlier grades, students are introduced to different ways of collecting data and use graphical displays and summary statistics to make comparisons. These ideas are revisited	O8.7: Identify differences, similarities and characteristics of single-blind, double-blind, observational and sample surveys. Determine survey type given a context. **(2 days)** O8.8: Use data from a sample survey to estimate a population mean or population proportion. **(2 days)**

Statistics and Probability **20 days**	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.	with a focus on how the way in which data is collected determines the scope and nature of the conclusions that can be drawn from that data. The concept of statistical significance is **developed** informally through simulation as meaning a result that is unlikely to have occurred solely as a result of random selection in sampling or random assignment in an experiment. For S.IC.4 and 5, focus on the variability of results from experiments—that is, focus on statistics as a way of dealing with, not eliminating, inherent randomness. If the difference of the sample means is more than 2 standard deviations from 0, then difference is significant. Placebo Effect	O8.9: Find the margin of error for a given survey. (**2 days)** O8.10: Calculate mean change to compare two treatments from random experiment data. Write statements that must be true based on the results. O8.11: Calculate mean change to compare two treatments from random experiment data and use this data to determine if the difference of the sample means is statistically significant or not. O8.12: Use knowledge of types of studies, calculating means and determining statistical significance to evaluate reports. **(2 days)** **End of Unit 8.** **Review and Quiz (2 days)**
	S-IC.5	Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.		
	S-IC.6	Evaluate reports based on data.		