Algebra II Mathematics Curriculum Guide

Grade Level/Course Title: Algebra II	**Quarter 1**	**Academic Year: 2015-2016**

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: (September) **Linear and Absolute Value Equations, Functions and Graphs (Algebra 1 Review)** **25 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 (of equations, inequalities, and absolute value equations and inequalities)	**** O1.2 means 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: Create equations in one-variable and use them to solve problems (up to equations with variables on both sides). O1.2: Solve equations in one-variable using the distributive property and commutative property. Solving Equations with Variables on Both Sides (L) O1.3: Create inequalities in one-variable and use them to solve problems. O1.4: Create absolute value equations in one variable and use them to solve problems. O1.5: Create absolute value inequalities in one variable and use them to solve problems. 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.		

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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 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 • Interval notation e.g. $3 \leq x < 5$ • Set notation e.g. [3, 5)	O1.6: Graph and create a table that represents linear situations. 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) O1.8: Create a table and graph from function 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)
	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-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. Experiment with cases and illustrate an explanation of the effects on the graph using 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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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 days** **(+): add 1 day**	F-IF.9	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in table, or by verbal descriptions).	• 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)	O1.10: 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 O1.11: Find the inverse of linear functions given a table, graph, or rule. Inverse Functions Key Curriculum: 5.5 (linear only) O1.12: Graph linear inequalities from slope-intercept form. Graphing Linear Inequalities Sort (L) O1.13: Graph absolute value functions by hand. **Emphasize function notation and finding the *x*- and *y*-intercepts. O1.14: Graph transformations of absolute value functions (include shifts left, right, up, down). Connecting Graphing and Solving Absolute Value Functions (pg 3&4) (L) O1.15(+): Graph transformations of absolute value functions (include vertical stretch/shrink and reflections). Key Curriculum: 4.6
	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), ~~and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.~~		
	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.		
	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. Experiment with cases and illustrate an explanation of the effects on the graph using technology.		

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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 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	O1.16: Write a linear equation given two data points. O1.17: Derive the point-slope form of a linear equation and use this to write functions from a context. Point-Slope Application Problems (L) **Review and Quiz (1 day)** O1.18: Use context problems to graph systems of linear equations and interpret their solution(s). Key Curriculum: 3.6 O1.19: Use context problems to solve systems of linear equations by substitution. Key Curriculum: 3.6 O1.20: Graph piecewise-defined functions using graphing knowledge of linear equations and absolute value equations. **Use context problems **(2 days)** Graphing Piecewise Functions (linears only) (L) **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 ~~square root, cube root, and~~ piecewise-defined functions, including step functions and absolute value functions. ★		

Algebra II Mathematics Curriculum Guide

Grade Level/Course Title: Algebra II	**Quarter 1-2**	**Academic Year: 2015-2016**

Mathematics Focus for the Course:
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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 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 by creating a table of values • Difference between -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. (domain, range, intercepts, increasing/decreasing on intervals, maximum/minimum values, vertex, axis of symmetry, concave up/down) **(2 days)** Key Features of Graphs (quadratics only) (L) O2.2: Find the average rate of change over an interval from a quadratic graph and from a quadratic equation. **Scaffolding includes function notation and evaluating functions. Average Rate of Change (pg 7–10) (L) 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 $f(x)=x^2$, $f(x)=-x^2$, $f(x)=x^2+3$, $f(x)=(x+3)^2$ by creating a table of values. Graph transformations of quadratic functions. Write a quadratic function given its graph. **(2 days)** Exploring Quadratic Graphs (L) Key Curriculum: 4.4
	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* (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*~~.		
	F-IF.7a (Algebra 1 standard)	Graph linear and quadratic functions and show intercepts, maxima, and minima.		

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Grade Level/Course Title: Algebra II	**Quarter 1-2**	**Academic Year: 2015-2016**

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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 days** **(+): add 1 day**	A-REI.4b (Algebra 1 standard)	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*.	• Build on family of functions by taking factored roots, *y*-intercept, and knowledge of concavity to sketch a graph of the function after each time you find the zeros. • What does *i* mean? • What are the properties of *i*? • Arithmetic operations on complex numbers • Complex roots vs. real roots and the relationship to the graph of a quadratic function • Mastery of solving a quadratic equation using an appropriate method • Vertex form	O2.5: Find *x*-intercepts/roots/zeros of quadratic functions by factoring. **(3 days)** Quadratics – Matching Game (L) **---- End of Algebra 1 Review ----** O2.6: Investigate the complex numbers and perform arithmetic operations on complex numbers. **(2 days)** Key Curriculum: 7.5 O2.7: Find the roots/zeros of quadratic functions using the Quadratic Formula. **Include real and imaginary roots **(2 days)** Key Curriculum: 7.4 O2.8: Find the roots/zeros of quadratic functions by completing the square. **Include real and imaginary roots/zeros **(2 days)** Key Curriculum: 7.3
	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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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 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**	• Difference between a quadratic equation and a circular equation • Piecewise functions as a spiraling activity for linear, absolute value, and quadratic function graphs • Inverse of $f(x) = x^2$-1 and other simple quadratic functions as square root functions • Use graphing calculators to visualize a quadratic function and its inverse as reflections over the line $y = x$	O2.9: Determine if 2nd degree functions represent parabolas or circles by completing the square. **(2 days)** O2.10: Graph piecewise-defined functions using graphing knowledge of linear and quadratic functions. **Use context problems O2.11(+): Find the inverse of quadratic functions by restricting the domain. Use technology to graph quadratic functions and their inverses. **End of Unit 2.** **Review, Assess, Reteach (3 days)** **Benchmark 1 will include Units 1 and 2.**
	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* $x \neq 1$.		
	F-IF.7b	Graph ~~square root, cube root~~, and piecewise-defined functions, ~~including step functions and absolute value functions~~.		

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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** **17 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 and 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)	O3.1: Identify the key features of the graphs of polynomials with degree greater than two. (General shape of the graph, odd/even graphs, end behavior, 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, interpret the multiplicity of its zeros: intersection or vertex (as applies to the graph), and match it to a potential graph. Key Curriculum: 7.7 O3.4: Given the graph of a polynomial, write a potential factored polynomial function based on its zeros. Key Curriculum: 7.7 O3.5: (Review) Factor quadratics to find zeros. O3.6: Factor cubics with a GCF that includes *x* (once GCF is factored, they will be quadratics) to find zeros. O3.7: Factor special quartics to find zeros.
	F-BF.3	*Recognize* [sic] *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. ★		
	F-BF.1	Write a function that describes a relationship between two quantities.★		
	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** **17 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	O3.8: Interpret the Remainder Theorem. O3.9: Use long division to find the zeros of a polynomial function. **(2 days)** Polynomial Division (L) O3.10: Use synthetic division to find the zeros of a polynomial function. O3.11: Perform side by side comparisons of long division, synthetic division, and evaluating a polynomial function to find its zeros. **(2 days)** Key Curriculum: 7.8 **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 • Finding the inverse function of a rational function	****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) O4.5: Solve rational equations in one variable and identify extraneous roots. **(2 days)** O4.6: Find the inverse function of a given rational function. **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.		
	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* $x \neq 1$.		

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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 days** **(+): add 1 day**	F-IF.7b	Graph square root, cube root, ~~and piecewise-defined~~ functions, ~~including step functions and absolute value functions.~~	• Square roots • 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 • (+) Interpret radical functions given a context	O5.1: Graph simple radical 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) O5.2: 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. O5.3: Find the average rate of change of a radical function over a given interval. O5.4: Simplify radicals. O5.5: Solve radical equations in one variable, including ones with extraneous roots. 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 O5.2 because these are exact values found by solving the equation.) O5.7: Given a radical function $f(x)$ and a linear function $g(x)$, find the intersection [point where $f(x) = g(x)$]. O5.8(+): Solve an applicable radical formula (e.g. from physics) for a specific variable.
	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. Experiment with cases and illustrate an explanation of the effects on the graph using technology.		
	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.		
	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. *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.*		
	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.		

Grade Level/Course Title: Algebra II	**Quarter 3**	**Academic Year: 2015-2016**

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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 days** **(+): add 1 day**	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* $x \neq 1$.	• 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)	O5.9: Find the inverse function of a given radical function. O5.10: 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)** **Benchmark 2 will include Units 3, 4, and 5.** **Should finish Unit 5 before February break.**
	F-IF.7b	Graph ~~square root, cube root~~, and piecewise-defined functions, ~~including step functions and absolute value functions~~.		

Algebra II Mathematics Curriculum Guide

Grade Level/Course Title: Algebra II	**Quarter 3**	**Academic Year: 2015-2016**

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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: (end Feb – beg. March) **Exponential and Logarithmic Equations, Functions and Graphs** **14 days** **(+): add 1 day**	F-IF.7e	Graph exponential and logarithmic functions, showing intercepts and end behavior, and ~~trigonometric functions, showing period, midline, and amplitude~~. ★	• 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: Find an exponential pattern in an activity, draw its graph, and write its equation. O6.2: Compare exponential and linear functions by comparing output patterns and differences in average rate of change. O6.3: Write an exponential equation given a context and solve for the exponential variable by creating equivalent bases. Solving Exponential Equations (L) Key Curriculum: 5.2 O6.4: Write an exponential equation with a percent growth rate. O6.5: Convert exponential equations to logarithmic equations and vice versa. Use the power property of logarithms to rewrite logarithmic equations. Introduction to Logarithms (L) O6.6: Express as a logarithmic algorithm the solution to contextual problems that use $ab^{ct} = d$. Evaluate this logarithm using technology. **(up to 2 days)**
	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)		

Algebra II Mathematics Curriculum Guide

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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** **14 days** **(+): add 1 day**	F-IF.7e	Graph exponential and logarithmic functions, showing intercepts and end behavior, and ~~trigonometric functions, showing period, midline, and amplitude~~. ★	• 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 and *e* • Fluency with transforming piecewise-defined functions between two representations (symbolic and graphic)	O6.7: 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) O6.8(+): Find the inverse of an exponential function. (e.g. inverse of $f(x) = 3^{x+1}$) Use the change of base property. O6.9: Define the natural logarithm and use it to solve problems. Interest and the Number e (L) O6.10: Graph a piecewise function given symbolically. Write a piecewise function given its graph. **Good spiraling activity. **End of Unit 6.** **Review, Assess, Reteach (3 days)**
	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 ~~square root, cube root~~, and piecewise-defined functions, ~~including step functions and absolute value functions~~.		

Algebra II Mathematics Curriculum Guide

Grade Level/Course Title: Algebra II	**Quarter 4**	**Academic Year: 2015-2016**

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** **21 days** **(+): add 5.5 days**	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 angles • Reference angle • Find coordinates of key points on the unit circle and relate them to sine and cosine • Special right triangle properties (30-60-90 and 45-45-90) • SOH CAH TOA • (+) Defining reciprocal functions: csc, sec, cot • Arc length • Radian measure	**** An alternative layout for this unit is to introduce radians at the beginning and use radians & degrees interchangeably** O7.1: Define a unit circle. **(half day)** O7.2: Sketch an angle (in degrees) in standard position on the unit circle. Include negative angles. **(half day)** O7.3: Find the reference angle of any angle in degrees. Include negative angles. **(half day)** O7.4: Explain why sine and cosine can be defined as coordinates on the unit circle. **(half day)** O7.5: Use special right triangle properties to determine key coordinates on a unit circle. Use angle measures 0º 90º, 180º, 270º, 360º first. Then, use 30º, 45º, 60º and extend to all quadrants. O7.6: Find exact values for sine, cosine, and tangent for each special argument (refer to O7.5) and arguments with the same reference angle. O7.7(+): Define the reciprocal functions and find exact values for them (given the values we already know). **(half day)** O7.8: Define a radian. What is a Radian? (L) Key Curriculum: beginning of 10.2
	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.		
	F-TF.1	Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.		

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Essential Questions for this Unit:
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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, Functions and Graphs** **21 days** **(+): add 5.5 days**	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 • Key features of trigonometric functions (emphasizing: 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?	O7.9: Translate between radians and degrees and vice versa. O7.10: Find exact values of sine, cosine, and tangent for special arguments in both radians and degrees. O7.11(+): Find exact values of cosecant, secant, and cotangent for special arguments in both radians and degrees. **Review and Quiz (1 day)** O7.12: Graph $f(x) = \sin x$, $f(x) = \cos x$, $f(x) = \tan x$. **(2 days)** O7.13: Identify key features of sine, cosine, tangent graphs (*x*-intercepts and *y*-intercept, increasing/decreasing intervals, domain and range, amplitude, period, midline, end behavior). **(2 days)** O7.14(+): Find the average rate of change over an interval on trigonometric graphs. O7.15: Graph transformations of sine and cosine functions. Key Curriculum: 10.3 O7.16: Graph dilations of sine and cosine functions. O7.17: Write a trigonometric function given its graph. **Why could a graph be BOTH a graph of sine and a graph of cosine?
	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. ★		
	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. Experiment with cases and illustrate an explanation of the effects on the graph using technology.		

Grade Level/Course Title: Algebra II	**Quarter 4**	**Academic Year: 2015-2016**

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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, Functions and Graphs** **21 days** **(+): add 5.5 days**	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 reciprocal trig functions • Verify trigonometric identities	O7.18: Model periodic phenomena with trigonometric functions. **(2 days)** Key Curriculum: 10.5 O7.19(+): Graph reciprocal trigonometric functions. O7.20: Prove and apply the trigonometric Pythagorean identities. Key Curriculum: 10.6 O7.21(+): Prove and apply the addition and subtraction formulas for trigonometric functions. Key Curriculum: 10.7 O7.22(+): 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.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.		
	F-TF.9	(+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.		
	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) **Statistics and Probability** **19 days**	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' 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.	**See Illuminate Item Bank for sample problems. O8.1: Find the mean and standard deviation 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 deviation given a data 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) O8.5: Given a context, determine if a survey method and its results are 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.1	Understand statistics as a process for making inferences about population parameters based on a random sample from that population.		
	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?		

Algebra II Mathematics Curriculum Guide

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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) **Statistics and Probability** **19 days**	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 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	O8.7: 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)** 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.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.		
	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.		