

Objective	Common Core Standards	What does this mean?
Polynomial, Rational, and Radical Relationships		
*Perform arithmetic operations with complex numbers	<p>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.</p> <p>N.CN.2 Use the relation $i^2=-1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.</p>	<p>Know that every number is a complex number of the form $a + bi$, where a and b are real numbers.</p> <p>Know that the complex number $i^2=-1$</p> <p>Apply the fact that the complex number $i^2=-1$. Use the associative, commutative, and distributive properties, to add, subtract, and multiply complex numbers.</p>
<p>*Use complex numbers in polynomial identities and equations.</p> <p><i>(Limit to polynomials with real coefficients.)</i></p>	<p>N.CN.7 Solve quadratic equations with real coefficients that have complex solutions.</p> <p>N.CN.8 Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$</p>	<p>Solve quadratic equations with real coefficients that have solutions of the form $a+bi$ and $a-bi$.</p> <p>Use polynomial identities to write equivalent expressions in the form of complex numbers.</p>
<p><i>(Limit to polynomials with real coefficients.)</i></p>	<p>N.CN.9 Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.</p>	<p>Understand the Fundamental Theorem of Algebra, which says that the number of complex solutions to a polynomial equation is the same as the degree of the polynomial. Show that this is true for a quadratic polynomial.</p>
*Interpret the structure of expressions.	A.SSE.1 Interpret expressions that represent a quantity in terms of its context.	Identify the different parts of the expressions and explain their meaning within the context of a problem.

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<p>(Extend to polynomial and rational expressions.)</p>	<p>a. Interpret parts of an expression, such as terms, factors, and coefficients.</p>	<p>See http://illustrativemathematics.org/standards/h/s-for-illustrations-of-many-of-these-standards Click on algebra, then Seeing Structure in Expressions</p>
<p>*Interpret the structure of expressions.</p> <p>(Extend to polynomial and rational expressions.)</p>	<p>b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)^n$ as the product of P and a factor not depending on P.</p> <p>A.SSE.2 Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$.</p> <p>Click here for illustrations. Click on Algebra, then Seeing Structure in Expressions, Show All and see illustrations for #2</p>	<p>Decompose expressions and make sense of the multiple factors and terms by explaining the meaning of the individual parts.</p> <p>Sorting Equations and Identities, a Mathematics Assessment Project Lesson</p> <p>Rewrite algebraic expressions in different equivalent forms such as factoring or combining like terms.</p> <p>*Use factoring techniques such as common factors, grouping, the difference of two squares, the sum or difference of two cubes, or a combination of methods to factor completely.</p> <p>*Simplify expressions including combining like terms, using the distributive property and other operations with polynomials.</p>
<p>*Write expressions in equivalent forms to solve problems.</p>	<p>A.SSE.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.</p>	<p>Develop the formula for the sum of a finite geometric series when the ratio is not 1.</p>

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<p><i>Consider extending A.SSE.4 to infinite geometric series in the curricular implementations of this course description.</i></p>		<p>Use the formula to solve real world problems such as calculating the height of a tree after n years given the initial height of the tree and the rate the tree grows each year. Calculate mortgage payments.</p>
<p>*Perform arithmetic operations on polynomials.</p>	<p>A.APR.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.</p>	<p>Understand the definition of a polynomial beyond quadratic polynomials.</p> <p>Understand the concepts of combining like terms and closure.</p> <p>Add, subtract, and multiply polynomials beyond quadratics and understand how closure applies under these operations.</p>
<p>*Understand the relationship between zeros and factors of polynomials.</p>	<p>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 $p(x)$.</p> <p>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.</p>	<p>Understand and apply the Remainder Theorem.</p> <p>Understand how this standard relates to A.SSE.3a.</p> <p>Understand that a is a root of a polynomial function if and only if $x-a$ is a factor of the function.</p> <p>Find the zeros of a polynomial when the polynomial is factored.</p> <p>Use the zeros of a function to sketch a graph of the function.</p>

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<p>*Use polynomial identities to solve problems.</p>	<p>A.APR.4 Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.</p> <p>A.APR.5 (+) Know and apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.</p>	<p>Understand that polynomial identities include but are not limited to the product of the sum and difference of two terms, the difference of two squares, the sum and difference of two cubes, the square of a binomial, etc.</p> <p>Prove polynomial identities by showing steps and providing reasons.</p> <p>Illustrate how polynomial identities are used to determine numerical relationships such as $25^2 = (20 + 5)^2 = 20^2 + 2 \cdot 20 \cdot 5 + 5^2$</p> <p>For small values of n, use Pascal's Triangle to determine the coefficients of the binomial expansion.</p> <p>Use the Binomial Theorem to find the nth term in the expansion of a binomial to a positive power.</p>
<p>*Rewrite rational expressions.</p>	<p>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.</p>	<p>Rewrite rational expressions by using factoring, long division, or synthetic division. Use a computer algebra system for complicated examples to assist with building a broader conceptual understanding.</p>

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<p>*Understand solving equations as a process of reasoning and explain the reasoning.</p>	<p>A.APR. 7 (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.</p> <p>A.REI.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.</p> <p>Click here to see illustrations. Click on Algebra, then Reasoning with Equations and Inequalities. Click Show All and see Illustrations under #2.</p>	<p>Simplify rational expressions by adding, subtracting, multiplying, or dividing.</p> <p>Understand that rational expressions are closed under addition, subtraction, multiplication, and division (by a nonzero expression).</p> <p>Interpreting Algebraic Expressions, a Mathematics Assessment Project Lesson</p> <p>Solve simple rational and radical equations in one variable and give examples of how extraneous solutions arise.</p> <p>http://youtu.be/711pdW8TbbY</p>

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<p>*Represent and solve equations and inequalities graphically</p>	<p>A.REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.</p>	<p>Explain why the intersection of $y = f(x)$ and $y = g(x)$ is the solution of $f(x)=g(x)$ for any combination of linear, polynomial, rational, absolute value, exponential, and logarithmic functions. Find the solution(s) by:</p> <ul style="list-style-type: none"> *using technology to graph the equations and determine their point of intersection *using tables of values, or *using successive approximations that become closer and closer to the actual value
<p>*Analyze functions using different representations.</p>	<p>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.</p> <p>F.IF.7c Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.</p> <p>Click here to see illustrations. Click on Functions, then Interpreting Functions, then Show All and see illustrations under #7.</p>	<p>Graph functions expressed symbolically and show key features of the graph. Graph simple cases by hand, and use technology to show more complicated cases including:</p> <p>Polynomial functions, identifying zeros when factorable, and showing end behavior</p> <p>Forming Quadratics, a Mathematics Assessment Project Lesson</p>
<p>Trigonometric Functions</p>		
<p>*Extend the domain of trigonometric functions using the unit circle.</p>	<p>F.TF.1 Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.</p>	<p>Know that if the length of an arc subtended by an angle is the same length as the radius of the circle, then the measure of the angle is 1 radian.</p>

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	<p>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.</p>	<p>Know that the graph of the function, f, is the graph of the equation $y = f(x)$ Explain how radian measures of angles rotated counterclockwise in a unit circle are in a one-to-one correspondence with the nonnegative real numbers, and that angles rotated clockwise in a unit circle are in a one-to-one correspondence with the non-positive real numbers.</p>
<p>*Model periodic phenomena with trigonometric functions.</p>	<p>F.TF.5 Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.</p>	<p>Use sine and cosine to model periodic phenomena such as the ocean's tide or the rotation of a Ferris wheel. Given the amplitude; frequency; and midline in situations or graphs, determine a trigonometric function used to model the situation.</p>
<p>*Prove and apply trigonometric identities.</p>	<p>F.TF.8 Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$, and the quadrant of the angle.</p>	<p>Use the unit circle to prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$. Given the value of the $\sin(\theta)$ or $\cos(\theta)$, use the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ to calculate other trigonometric ratios.</p>
Modeling With Functions		
<p>*Create equations that describe numbers or relationships.</p>	<p>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.</p>	<p>Create linear, quadratic, rational and exponential equations and inequalities in one variable and use them in a contextual situation to solve problems.</p>

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	<p>A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</p> <p>A.CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.</p> <p>A.CED.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.</p>	<p>Click here to see illustrations. Click on Algebra, then Creating Equations, then Show All. See illustrations under #1.</p> <p>Create equations in two or more variables to represent relationships between quantities.</p> <p>Graph equations in two variables on a coordinate plane and label the axes and scales.</p> <p>Write and use a system of equations and/or inequalities to solve a real world problem. Recognize that the equations and inequalities represent the constraints of the problem. Use the Objective Equation and the Corner Principle to determine the solution to the Problem. (Linear Programming)</p> <p>Click here to see illustrations. Click on Algebra, then Creating Equations, then Show All and see illustration under #3.</p> <p>Solve multi-variable formulas or literal equations, for a specific variable.</p>

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<p>*Interpret functions that arise in applications in terms of a context.</p> <p><i>Emphasize the selection of a model function based on behavior of data and context.</i></p>	<p>F.IF.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.</p> <p>F.IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function $h(n)$ gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.</p> <p>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.</p>	<p>What does this mean?</p> <p>Given a function, identify key features in graphs and tables including: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.</p> <p>Given the key features of a function, sketch the graph.</p> <p>Given the graph of a function, determine the practical domain of the function as it relates to the numerical relationship it describes.</p> <p>Calculate the average rate of change over a specified interval of a function presented symbolically or in a table.</p> <p>Estimate the average rate of change over a specified interval of a function from the function's graph.</p>

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<p>*Analyze functions using different representations.</p>	<p>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.</p> <p>F.IF.7 b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.</p> <p>F.IF.7e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.</p> <p>F.IF.8 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.</p> <p>F.IF.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.</p>	<p>Interpret, in context, the average rate of change of a function over a specified interval.</p> <p>Graph functions expressed symbolically and show key features of the graph. Graph simple cases by hand, and use technology to show more complicated cases including: Square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.</p> <p>Trigonometric functions, showing period, midline, and amplitude.</p> <p>Write a function in equivalent forms to show different properties of the function.</p> <p>Explain the different properties of a function that are revealed by writing a function in equivalent forms.</p> <p>Compare the key features of two functions represented in different ways. For example, compare the end behavior of two functions, one of which is represented graphically and the other is represented symbolically.</p>

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<p>*Build a function that models a relationship between two quantities.</p> <p><i>Develop models for more complex or sophisticated situations than in previous courses.</i></p>	<p>F.BF.1 Write a function that describes a relationship between two quantities.</p> <p>F.BF.1b Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.</p>	<p>Combine standard function types, such as linear and exponential, using arithmetic operations.</p>
<p>*Build new functions from existing functions.</p>	<p>F.BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k \cdot f(x)$, $f(kx)$, and $f(x+k)$ for 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.</p> <p>F.BF.4 Find inverse functions.</p> <p>F.BF.4a Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse. For example, $f(x) = 2x^3$ or $f(x) = (x+1)/(x-1)$ for $x \neq 1$.</p>	<p>Identify, through experimenting with technology, the effect on the graph of a function by replacing $f(x)$ by $f(x) + k$, $k \cdot f(x)$, $f(kx)$, and $f(x+k)$ for specific values of k (both positive and negative)</p> <p>Given the graphs of the original function and a transformation, determine the value of k. Recognize even and odd functions from their graphs and equations.</p> <p>Solve a function for the dependent variable and write the inverse of a function by interchanging the values of the dependent and independent variables.</p>

Objective	Common Core Standards	What does this mean?
<p>*Construct and compare linear, quadratic, and exponential models and solve problems.</p>	<p>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.</p>	<p>Express logarithms as solutions to exponential functions using bases 2, 10, and e.</p> <p>Use technology to evaluate a logarithm.</p>
Inferences and Conclusions from Data		
<p>*Summarize, represent, and interpret data on a single count or measurement variable.</p> <p><i>Build on students' understanding of data distributions to help them see how the normal distribution uses area to make estimates of frequencies. Emphasize that only some data are well described by a normal distribution.</i></p>	<p>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.</p>	<p>Identify data sets as approximately normal or not.</p> <p>Use the mean and standard deviation to fit it to a normal distribution where appropriate.</p> <p>Use calculators, spreadsheets, and tables to estimate areas under the normal curve.</p> <p>Interpret areas under a normal curve in context.</p> <p>A Case of Muddying the Waters, a Mathematics Assessment Project Lesson</p>

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<p>*Understand and evaluate random processes underlying statistical experiments.</p> <p><i>Include comparing theoretical and empirical results to evaluate the effectiveness of a treatment.</i></p>	<p>S.IC.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.</p> <p>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?</p>	<p>Explain in context the difference between values describing a population and a sample. Explain how well and why a sample represents the variable of interest from a population.</p> <p>Demonstrate understanding of the different kinds of sampling methods.</p> <p>Design simulations of random sampling: assign digits in appropriate proportions for events, carry out the simulation using random number generators and random number tables and explain the outcomes in context of the population and the known proportions.</p>
<p>*Make inferences and justify conclusions from sample surveys, experiments, and observational studies.</p>	<p>S.IC.3 Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.</p>	<p>Identify situations as either sample survey, experiment, or observational study. Discuss the appropriateness of each one's use in contexts with limiting factors.</p> <p>Design or evaluate sample surveys, experiments and observational studies with randomization. Discuss the importance of randomization in these processes.</p>

Objective	Common Core Standards	What does this mean?
<p><i>Focus on the variability of results from experiments. Focus on statistics as a way of dealing with, not eliminating, inherent randomness.</i></p>	<p>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.</p> <p>S.IC.5 Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.</p> <p>S.IC.6 Evaluate reports based on data.</p>	<p>Use sample means and sample proportions to estimate population values.</p> <p>Conduct simulations of random sampling to gather sample means and sample proportions. Explain what the results mean about variability in a population and use results to calculate margins of error for these estimates.</p> <p>Evaluate effectiveness and differences in two treatments based on data from randomized experiments. Explain in context.</p> <p>Use simulations to generate data simulating application of two treatments. Use results to evaluate significance of differences.</p> <p>Read and explain in context data from outside reports.</p>
<p>*Use probability to evaluate outcomes of decisions.</p>	<p>S.MD.6 (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).</p> <p>S.MD.7 (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).</p>	<p>Make decisions based on expected values. Use expected values to compare long term benefits of several situations.</p> <p>Explain in context decisions made based on expected values.</p>