Curriculum 2.0 Precalculus Standards

Unit 1: Polynomial, Power, and Rational Functions

Topic 1: Piecewise-Defined Functions/Composition of Functions (Honors: Limits)

Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (A.SSE.B.3)

Understand the concept of limit of a function. (F.IF.A.2a)

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

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

Interpret the behavior of the graph of a function using the concept of limit. (F.IF.C.8c)

Estimate limits numerically, algebraically, and graphically. (F.IF.C.8d)

Write a function that describes a relationship between two quantities, including more complex functions. (F.BF.A.1)

Compose functions. (F.BF.A.1c)

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.BF.B.3)

Verify by composition that one function is the inverse of another. (F.BF.B.4b)

Produce an invertible function from a non-invertible function by restricting the domain. (F.BF.B.4d)

Topic 2: Power Functions

Use the structure of an expression to identify ways to rewrite it. (A.SSE.A.2)

Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (A.SSE.B.3)

For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities; sketch graphs showing key features given a verbal description of the relationship. (F.IF.B.4)

Interpret the behavior of the graph of a function using the concept of limit. (F.IF.C.8c)

Write a function that describes a relationship between two quantities, including more complex functions. (F.BF.A.1)

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.BF.B.3)

Topic 3: Graphs of Rational Functions Extended

For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities; sketch graphs showing key features given a verbal description of the relationship. (F.IF.B.4)

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

Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. (F.IF.C.8)

Interpret the behavior of the graph of a function using the concept of limit. (F.IF.C.8c)

Topic 4: The Algebra of Rational Expressions/Equations/Inequalities (Honors: Partial Fractions)

Rewrite simple rational expressions in different forms. (A.APR.D.6)

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

Solve equations and inequalities in one variable. (A.REI.B)

Unit 1 Supporting Standards

Use the structure of an expression to identify ways to rewrite it. (A.SSE.A.2)

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

Write a function that describes a relationship between two quantities, including more complex functions. (F.BF.A.1)

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.BF.B.3)

Unit 2: Exponential and Logarithmic Functions

Topic 1: Extensions to any Base/Laws of Logarithms/Change of Base

Use the structure of an expression to identify ways to rewrite it. (A.SSE.A.2)

Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents. (F.BF.B.5)

Topic 2 – Solving Exponential and Logarithmic Equations

Solve equations and inequalities in one variable. (A.REI.B)

Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents. (F.BF.B.5)

Use properties of logarithms, including both common and natural logarithms, to rewrite and solve exponential models. (F.LE.A.4a)

Unit 2 Supporting Standards:

For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities; sketch graphs showing key features given a verbal description of the relationship. (F.IF.B.4)

Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. (F.IF.C.8)

Write a function that describes a relationship between two quantities, including more complex functions. (F.BF.A.1)

Unit 3: Trigonometric Functions

Topic 1: Special Angles and Reciprocal Trigonometric Functions

Interpret the behavior of the graph of a function using the concept of limit. (F.IF.C.8c)

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. (F.TF.A.2)

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

Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions. (F.TF.A.4)

Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline. (F.TF.B.5)

Topic 2: Inverse Trigonometric Functions

Interpret the behavior of the graph of a function using the concept of limit. (F.IF.C.8c)

Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed. (F.TF.B.6)

Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. (F.TF.B.7)

Topic 3: Trigonometric Identities and Equations

Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. (F.TF.B.7)

Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems. (F.TF.C.9)

Use trigonometric identities to rewrite expressions and as a tool when solving trigonometric equations. (F.TF.C.9a)

Topic 4: Laws of Sines and Cosines

Derive the formula $A = \frac{1}{2}ab\sin C$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side. (G.SRT.D.9)

Prove the Laws of Sines and Cosines and use them to solve problems. (G.SRT.D.10)

Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces). (G.SRT.D.11)

Unit 3 Supporting Standards:

For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities; sketch graphs showing key features given a verbal description of the relationship. (F.IF.B.4)

Write a function that describes a relationship between two quantities, including more complex functions. (F.BF.A.1)

Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline. (F.TF.B.5)

Unit 4: Vectors and Parametrics

Topic 1: The Algebra of Vectors

Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints. (N.CN.B.6)

Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., $\boldsymbol{v}$, $|\boldsymbol{v}|$, $\|\boldsymbol{v}\|$, v). (N.VM.A.1)

Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. (N.VM.A.2)

Solve problems involving velocity and other quantities that can be represented by vectors. (N.VM.A.3)

Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes. (CCSS: N.VM.B.4a)

Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. (N.VM.B.4b)

Understand vector subtraction $\boldsymbol{v} - \boldsymbol{w}$ as $\boldsymbol{v} + (-\boldsymbol{w})$, where $-\boldsymbol{w}$ is the additive inverse of $\boldsymbol{w}$, with the same magnitude as $\boldsymbol{w}$ and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise. (N.VM.B.4c)

Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c\langle v_x, v_y\rangle = \langle cv_x, cv_y\rangle$. (N.VM.B.5a)

Compute the magnitude of a scalar multiple $c\boldsymbol{v}$ using $|c\boldsymbol{v}| = |c|\boldsymbol{v}$. Compute the direction of $c\boldsymbol{v}$ knowing that when $|c|\boldsymbol{v} \neq 0$, the direction of $c\boldsymbol{v}$ is either along $\boldsymbol{v}$ (for $c > 0$) or against $\boldsymbol{v}$ (for $c < 0$). (CCSS: N.VM.B.5b)

Determine the dot product of two vectors. (N.VM.B.5c)

Topic 2: Parametrically-Defined Functions (Honors: Vector-Valued Functions)

Sketch the curve defined by parametric equations. (P.IPE.A.1)

Use parametric equations to model and solve motion problems. (P.IPE.A.2)

Create a single equation, using rectangular coordinates, that is equivalent to a pair of parametric equations. (P.CED.A.1)

Given a data set, create a parametric equation and a single equation using rectangular coordinates to fit the data. (P.CED.A.2)

Topic 3 (H): Polar Curves/Complex Numbers in Polar Form

Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers. (N.CN.A.3)

Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number. (N.CN.B.4)

Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, $\left(-1 + i\sqrt{3}\right)^3 = 8$ *because* $\left(-1 + i\sqrt{3}\right)$ *has modulus* 2 *and argument* 120°. (N.CN.B.5)

Understand the relationship between polar coordinates and Cartesian coordinates. (G.GPE.C.1)

Convert between polar and rectangular coordinates. (G.GPE.C.2)

Plot points on a polar coordinate grid. (G.GPE.C.3)

Convert equations between polar and rectangular forms. (G.GPE.D.1)

Graph polar equations by hand and using technology. (G.GPE.D.2)

Solve systems of polar equations. (G.GPE.D.3)

Unit 5: Systems and Matrices

Topic 1: The Algebra of Matrices

Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network. (N.VM.C.6)

Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled. (N.VM.C.7)

Add, subtract, and multiply matrices of appropriate dimensions. (N.VM.C.8)

Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties. (N.VM.C.9)

Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse. (N.VM.C.10)

Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors. (N.VM.C.11)

Work with 2×2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area. (N.VM.C.12)

Topic 2: Applications of Matrices

Represent a system of linear equations as a single matrix equation in a vector variable. (A.REI.C.8)

Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3×3 or greater). (A.REI.C.9)

Supporting Standards

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

Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. (A.REI.C.6)

Unit 6: Discrete Math

Topic 1: Combinatorics/Binomial Theorem

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. (A.APR.C.5)

Use permutations and combinations to compute probabilities of compound events and solve problems. (S.CP.B.9)

Topic 2: Sequences and Series

Use the notation for the factorial of a non-negative integer, $n!$, to evaluate expressions. (N.OA.A.1)

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.* (A.SSE.B.4)

Express the sum in a series using sigma notation. (A.SSE.B.4a)

Determine the sum, if it exists, of an infinite geometric series. (A.SSE.B.5)

Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. (F.IF.A.3)

Estimate limits numerically, algebraically, and graphically. (F.IF.C.8d)

Describe the behavior of a sequence. (F.IF.C.10)