Mathematics Standard
Catalina Foothills School District
High School: Precalculus

Precalculus will extend and refine algebraic and trigonometric concepts introduced and developed in Algebra 2. This course emphasizes critical and creative thinking in its design for students who wish to further their advanced algebra skills. Precalculus is taught at a level and pace to prepare students for AP Calculus AB.

Standard for Precalculus by Unit and Measurement Topic

UNIT 1: FUNCTIONS	
Functions: Building Functions (F-BF)	
HS.F-BF.1	Write a function that describes a relationship between two quantities. a. Determine an explicit expression, a recursive process, or steps for calculation from a context. b. 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.* c. Compose functions. *For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.*
HS.F-BF.3	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, 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.*
HS.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 $x \neq 1$. b. Verify by composition that one function is the inverse of another. c. Read values of an inverse function from a graph or a table, given that the function has an inverse. d. Produce an invertible function from a non-invertible function by restricting the domain.
Functions: Interpreting Functions (F-IF)	
HS.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. b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. d. Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior. e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.
UNIT 2: POLYNOMIALS	
Number and Quantity: The Complex Number System (N-CN)	
HS.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.
HS.N-CN.2	Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.
HS.N-CN.8	Extend polynomial identities to the complex numbers. *For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$.*
HS.N-CN.9	Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

Algebra: Arithmetic with Polynomials and Rational Expressions (A-APR)	
HS.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.*
UNIT 3: RATIONAL FUNCTIONS	
Algebra: Arithmetic with Polynomials and Rational Expressions (A-APR)	
HS.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.
Functions: Interpreting Functions (F-IF)	
HS.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
UNIT 4: EXPONENTIAL AND LOGARITHMIC FUNCTIONS	
Functions: Linear, Quadratic, and Exponential Models (F-LE)	
HS.F-LE.2	Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
HS.F-LE.3	Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
HS.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.
HS.F-LE.5	Interpret the parameters in a linear or exponential function in terms of a context.
Functions: Building Functions (F-BF)	
HS.F-BF.3	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, 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.*
HS.F-BF.5	Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.
Functions: Interpreting Functions (F-IF)	
HS.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. a. Graph exponential and logarithmic functions, showing intercepts and end behavior.
HS.F-IF.8	Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. b. Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as* $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, *and classify them as representing exponential growth or decay.*
Algebra: Seeing Structure in Expressions (A-SSE)	
HS.A-SSE.3	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. c. Use the properties of exponents to transform expressions for exponential functions. *For example the expression* 1.15^t *can be rewritten as* $(1.15^{1/12})^{12t} \approx 1.012^{12t}$ *to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.*
UNIT 5: CONIC STRUCTURES	
Geometry: Expressing Geometric Properties with Equations (G-GPE)	
HS.G-GPE.3	Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.
Functions: Interpreting Functions (F-IF)	
HS.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.
UNIT 6: GRAPHING TRIGONOMETRIC FUNCTIONS	
Functions: Trigonometric Functions (F-TF)	
HS.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.
HS.F-TF.4	Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.
HS.F-TF.5	Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.
Functions: Building Functions (F-BF)	

HS.F-BF.3	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, 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.*
UNIT 7: INVERSE TRIGONOMETRIC FUNCTIONS	
Functions: Trigonometric Functions (F-TF)	
HS.F-TF.6	Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.
UNIT 8: TRIGONOMETRIC IDENTITIES	
Functions: Trigonometric Functions (F-TF)	
HS.F-TF.8	Prove the Pythagorean Identity $\sin^2\theta + \cos^2\theta = 1$ and use it to find sinθ, cosθ, or tanθ given sinθ, cosθ, and tanθ and the quadrant of the angle.
HS.F-TF.9	Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.
UNIT 9: SOLVING TRIGONOMETRIC FUNCTIONS	
Functions: Trigonometric Functions (F-TF)	
HS.F-TF.7	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.
UNIT 10: COMPLEX NUMBER SYSTEM AND POLAR COORDINATES	
Number and Quantity: The Complex Number System (N-CN)	
HS.N-CN.3	Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.
HS.N-CN.4.	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.
HS.N-CN.5	Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation.
HS.N-CN.6.	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.
UNIT 11: SOLVING OBLIQUE TRIANGLES AND VECTORS	
Number and Quantity: Vector and Matrix Quantities (N-VM)	
HS.N-VM.1	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., v, $\|v\|$, $\|\|v\|\|$, v).
HS.N-VM.2	Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
HS.N-VM.3	Solve problems involving velocity and other quantities that can be represented by vectors.
HS.N-VM.4	Add and subtract vectors. a. 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. b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. c. Understand vector subtraction $v - w$ as $v + (-w)$, where $-w$ is the additive inverse of w, with the same magnitude as 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.
HS.N-VM.5	Multiply a vector by a scalar. a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$. b. Compute the magnitude of a scalar multiple cv using $\|\|cv\|\| = \|c\|v$. Compute the direction of $c\mathbf{v}$ knowing that when $\|c\|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$).
Geometry: Similarity, Right Triangles, and Trigonometry (G-SRT)	
HS.G-SRT.9	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.
HS.G-SRT.10	Prove the Laws of Sines and Cosines and use them to solve problems.
HS.G-SRT.11	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).
UNIT 12: MATRICES	
Number and Quantity: Vector and Matrix Quantities (N-VM)	
HS.N-VM.6	Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.
HS.N-VM.7	Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.

HS.N-VM.8	Add, subtract, and multiply matrices of appropriate dimensions.
HS.N-VM.9	Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.
HS.N-VM.10	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.
HS.N-VM.11	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.
HS.N-VM.12	Work with 2×2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.
Algebra: Reasoning with Equations and Inequalities ★ (A-REI)	
HS.A-REI.8	Represent a system of linear equations as a single matrix equation in a vector variable.
HS.A-REI.9	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).
UNIT 13: SEQUENCES AND SERIES	
Functions: Linear, Quadratic, and Exponential Models (F-LE)	
HS.F-LE.2	Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
Functions: Building Functions (F-BF)	
HS.F-BF.2	Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.
HS.F-BF.1	Write a function that describes a relationship between two quantities. a. Determine an explicit expression, a recursive process, or steps for calculation from a context. b. 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.* c. Compose functions. *For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.*
Algebra: Seeing Structure in Expressions (A-SSE)	
HS.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.*
STANDARDS FOR MATHEMATICAL PRACTICE	
HS.MP.1	Make sense of problems and persevere in solving them.
HS.MP.2	Reason abstractly and quantitatively.
HS.MP.3	Construct viable arguments and critique the reasoning of others.
HS.MP.4	Model with mathematics.
HS.MP.5	Use appropriate tools strategically.
HS.MP.6	Attend to precision.
HS.MP.7	Look for and make use of structure.
HS.MP.8	Look for an express regularity in repeated reasoning.