MCPS Precalculus/*Honors Precalculus* Framework

Note: All italicized items are for honors only.

Unit 1: Polynomial, Power, and Rational Functions

Topic 1: Piecewise-Defined Functions/Composition of Functions/*Limits* (Students will know that…)

- Piecewise-defined functions can be used to model real-world situations.
- Some basic function types (i.e., absolute value) can be expressed as piecewise-defined functions.
- Functions can be combined by composition.
- Composition of functions can be used to verify that two functions are inverses.
- If a function is one-to-one, then its inverse is also a function.
- Functions can be classified as even, odd, or neither using the definitions.
- The behavior of a function near a point can be used to classify a function as continuous or to identify the type of discontinuity.
- *The concept of limits can be applied to describe the behavior of functions.*

Topic 2: Power Functions (Students will know that…)

- A function of the form $f(x) = k\,x^a$, where *k* and *a* are real numbers, represents a power function, whose properties are dependent on the value of *k* and *a*.
- *The concept of limits can be applied to describe the behavior of power functions.*

Topic 3: Graphs of Rational Functions Extended (Students will know that…)

- The graph of a rational function, whose denominator is at most quadratic, can be analyzed in terms of its domain, range, intercepts, asymptotes (vertical, horizontal, oblique) and discontinuities.
- *The concept of limits can be applied to describe the behavior of rational functions.*

Topic 4: The Algebra of Rational Expressions/Equations/Inequalities (Students will know that…)

- Rational expressions can be combined using arithmetic operations.
- *Some rational expressions can be expressed as the sum of two or more other rational expressions by partial fraction decomposition (Denominators should be products of linear and non-repeating factors).*
- Polynomial inequalities can be used to solve real-world problems.
- Rational equations and inequalities (denominators at most quadratic) can be used to solve real-world problems.

Unit 2: Exponential and Logarithmic Functions

Topic 1: Extensions to any Base/Laws of Logarithms/Change of Base (Students will know that…)

- Properties of logarithms (e.g., product, quotient, and power) are extensions of the properties of exponents.

Topic 2: Solving Exponential and Logarithmic Equations (Students will know that…)

- Exponential and logarithmic equations can be solved by using the properties of logarithms.
- Exponential and logarithmic functions can be applied to real-world problems.

Unit 3: Trigonometric Functions

Topic 1: Special Angles and Reciprocal Trigonometric Functions (Students will know that...)

- The set of trigonometric/circular functions can be extended to the reciprocal functions cotangent, secant, and cosecant.
- The characteristics of the cotangent, secant, and cosecant functions can be determined by using the characteristics of the sine, cosine, and tangent functions, respectively.
- Special triangles can be used to geometrically determine the values of the six trigonometric functions at $\frac{\pi}{6}, \frac{\pi}{4}, \frac{\pi}{3}$, and their integral multiples.
- The unit circle can be used 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.

Topic 2: Inverse Trigonometric Functions (Students will know that…)

- Restricting the domain of a trigonometric function so that it is always increasing or decreasing on an interval allows its inverse to be constructed.

Topic 3: Trigonometric Identities and Equations (Students will know that…)

- Trigonometric expressions can be rewritten using sum and difference, double, half-angle, and Pythagorean identities.
- Trigonometric identities can be proven using graphs and basic identities (reciprocal, sum and difference, double, half-angle, and Pythagorean).
- Choose trigonometric equations to model real-world situations including amplitude, period, midline, and phase shift.
- Inverse functions can be used to solve trigonometric equations that arise from a context.

Topic 4: Laws of Sines and Cosines (Students will know that…)

- Unknown measurements of non-right triangles can be found using the Laws of Sines and Cosines.

- *When the measurements of two sides and an angle that is not between them (SSA)are given, there may be two possible triangles, and the Law of Sines can be used to find the unknown measurements of both.*

Unit 4: Vectors, Parametrics, and *Polars*

Topic 1: The Algebra of Vectors (Students will know that…)

- Vector quantities represent magnitude and direction and can be represented as directed line segments.
- Vectors can be added, subtracted and multiplied by a scalar both geometrically and symbolically.
- Vectors can be multiplied using a dot product.
- Vectors can be used to solve problems involving velocity and other quantities.

Topic 2: Parametrically-Defined Functions/*Vector-Valued Functions* (Students will know that…)

- Parametrically defined functions can be used to model motion in the plane.
- *Vector-valued functions can be used to model real-world situations.*

Topic 3: Polar Curves/Complex Numbers in Polar Form *(Students will know that…)*

- *Complex numbers can be represented on the complex plane in rectangular (e.g.,* $a+bi$*) and polar (e.g.,* $r\left(\cos\theta+i\sin\theta\right)$*) form.*
- *Arithmetic operations (addition, subtraction, multiplication, division, conjugation, exponentiation) can be represented geometrically on the complex plane and their polar representations can be used to perform these operations.*
- *The distance between two complex numbers in the plane can be calculated.*
- *Some functions can be represented more efficiently by a polar form. (e.g.,* $r=f\left(\theta\right)$*)*
- *Functions in polar form can be graphed on the coordinate plane.*
- *A function in rectangular form can be rewritten in polar form and vice versa.*
- *Systems of polar equations can be solved symbolically and graphically.*

Unit 5: Systems and Matrices

Topic 1: The Algebra of Matrices (Students will know that…)

- Matrices can be used to model and manipulate data.
- Matrices of appropriate dimensions can be added, subtracted and multiplied, and can be multiplied by a scalar.
- Matrix multiplication is not commutative for square matrices, but the distributive and associative properties apply.
- There are additive and multiplicative identity matrices.

Topic 2: Applications of Matrices (Students will know that…)

- Matrices can be used to perform transformations in the plane.
- Systems of equations can be written as a matrix/vector equation, which can be solved using multiplicative inverse of a matrix.

Unit 6: Discrete Math

Topic 1: Combinatorics/Binomial Theorem (Students will know that…)

- The Fundamental Counting Principle, permutations, combinations, and factorials can be used to determine probabilities of compound events and to solve problems.
- The Binomial Theorem can be used to expand $(x+y)^n$.

Topic 2: Sequences and Series *(Summation Notation)* (Students will know that…)

- The sum of the terms of a sequence is a series.
- The sequence of partial sums of a series can be expressed recursively or explicitly.
- Sums of finite geometric series can be used to solve real-world problems.
- *An infinite series will have a sum if the sequence of partial sums has a limit, as the number of terms increases without bound.*
- An infinite geometric series will have a sum of $S = \frac{a_1}{1-r}$, if $0 < |r| < 1$
- *Series can be expressed using summation notation.*

Unit 7: Analytic Geometry in Three Dimensions (Optional)

Topic 1: The 3D Cartesian Coordinate System *(Student will know that…)*

- *Space can be coordinatized using an x-, y-, and z-axis.*
- *Formulas (i.e., distance, midpoint, vector operations), equations of figures (i.e., lines, planes, spheres), and motion in space (i.e., parametrics, vectors), can be represented in two- and three-dimensional coordinate systems.*

