

K – 12 MATHEMATICS UNIFYING STANDARDS

- 1.0 Number Sense and Operations** – Students understand ways of representing numbers, relationships among numbers, and number systems. They understand the meaning of and relationships between operations and strategies, and they can estimate appropriately.
- 2.0 Patterns, Functions, and Algebra** – Students know and understand various types of patterns and functional relationships. They use symbolic forms and models to represent and analyze mathematical structures in both real and abstract contexts.
- 3.0 Measurement** – Students know and understand attributes, units and systems of measurement. They apply a variety of techniques, tools, and formulas for determining measurements.
- 4.0 Geometry and Spatial Sense** – Students know how to analyze characteristics and properties of two- and three- dimensional objects. They select and use different representational systems, including coordinate and graph theory. They understand the usefulness of transformations and symmetry in analyzing mathematical situations. They know how to visualize and to use spatial reasoning to solve problems that cross disciplines.
- 5.0 Data Analysis, Statistics, and Probability** – Students know how to pose questions and collect, organize, represent and interpret data in order to answer those questions. They use methods of exploratory data analysis to develop and evaluate inferences, predictions, and arguments that are based on data. They understand and know how to apply the notions of chance and probability.
- 6.0 Problem Solving** – Students know that they learn basic skills and concepts in order to use them to solve problems in and out of school. They solve routine and complex problems by drawing from a variety of strategies, including technology, while demonstrating an attitude of persistence and reflection in their approaches.
- 7.0 Processes: Reasoning, Communication, and Connections** – Students use reasoning to develop, analyze, draw conclusions, and validate conjectures and arguments. As they reason, they recognize and understand multiple representations of the same concept. They see the interconnections among math ideas, as well as in other disciplines. They know how to communicate their math thinking clearly and coherently to others, orally, graphically, and in writing, using precise language and symbols.

**FOCUS GOALS
HONORS PRE-CALCULUS**

1.0 Number Sense and Operations

- 7.1 Understand and use the real and complex numbers in both rectangular " $a+bi$ " and polar " $rcis$ " form.
- 7.2 Understand and use laws of logarithm.
- 7.3 Understand and use matrices.
- 7.4 Understand, interpret and use vector operations.
- 7.5 Understand the basic operations and properties of sigma notation.

2.0 Patterns, Functions, and Algebra

- 2.1 Understand the properties of functions and their graphs: absolute value, polynomial, composite, exponential, logarithmic, rational, trigonometric, piece-wise, and greatest integer.
- 2.2 Understand and apply the specific properties of polynomials.
- 2.3 Interpret solution sets of systems.
- 2.4 Understand and use trigonometric identities and formulas.
- 2.5 Understand how to use sequences and series.
- 2.6 Understand functions and equations defined parametrically.
- 2.7 Know the algebraic and graphical interpretation of limit of values of functions.
- 2.8 Know the formal definition and graphical interpretation of continuity of a function.
- 2.9 Understand and explain the concept of derivative of a function.

3.0 Measurement

- 3.1 Select and use appropriate units and scales of measurement.
- 3.2 Convert between, or within various systems of measurement.
- 3.3 Understand the relationship of function units as it relates to position, velocity, and/or acceleration.

4.0 Geometry and Spatial Sense

- 4.1 Demonstrate an understanding of the geometric interpretation of vectors in two and three dimensions.
- 4.2 Understand and demonstrate the geometry of trigonometry.
- 4.3 Transform the graphs of a function.
- 4.4 Use differentiation to sketch, by hand, graphs of functions.
- 4.5 Interpret geometrically the solution sets of systems of equations.
- 4.6 Translate between polar and rectangular coordinates and understand these relationships graphically.
- 4.7 Be familiar with conic sections, both analytically and graphically.
- 4.8 Understand and apply the components of a graph of a function.

5.0 Data Analysis, Statistics, and Probability

- 5.1 Organize, represent, and interpret data in graphs.

6.0 Problem Solving

- 6.1 Make decisions about how to approach problems.
- 6.2 Apply one or more mathematical relations to solve mathematical and real world problems.
- 6.3 Use calculators/computers to solve mathematical problems, model physical phenomenon, introduce new concepts, and verify conjectures.

7.0 Processes: Reasoning, Communications, and Connections

- 7.1 Communicate math thinking and conclusions using words, graphs, and charts.
- 7.2 Demonstrate proofs of various formulas.
- 7.3 Apply math skills to new situations.
- 7.4 Be familiar with the formal definition of the derivative and its derivation.
- 7.5 Apply literacy skills when making mathematical connections.

MATH STANDARDS HONORS PRE-CALCULUS

1.0 Number Sense and Operations – Students understand ways of representing numbers, relationships among numbers, and number systems. They understand the meaning of and relationships between operations and strategies, and they can estimate appropriately.

1.1 Understand and use the real and complex numbers in both rectangular “ $a+bi$ ” and polar “ $rcis$ ” form. (p/c)

- Add, subtract, multiply, and plot complex numbers. (c/t17C/a5,6)
- Convert from rectangular to polar and vice versa. (c/ma1.0)
- Find the n th root or n th power of complex number. (c/t18)
- Explain and use DeMoivre’s Theorem. (c/ma2/t18)

1.2 Understand and use laws of logarithm. (c/aII13/p)

- Use the concept of limits and its notation. (c/ma8)
- Explain the concept of infinity as increasing without bound and its usage. (p)

1.3 Understand and use matrices. (c/C/a4,5,9,10)

- Add, subtract, multiply (scalar and matrix) using matrices. (c/la4,5)
- Find identities, determinants, and inverses of 2 by 2 and 3 by 3 matrices. (c/la9,10)
- Order information in matrix form. *
- Reduce rectangular matrices to row echelon form. (c/la3)

1.4 Understand, interpret and use vector operations. (p/c/la7)

- Apply addition, subtraction, and scalar multiplication. (c/la5,7)
- Complete the dot product of two vectors in a dimensional space. (c/la12)
- Recognize that perpendicular vectors have zero dot products. (la12)
- Complete cross products. *

1.5 Understand the basic operations and properties of sigma notation. *

- Apply addition, subtraction, and scalar multiplication.
- Derive summative formulas and use sigma notation to represent both finite and infinite series. (aII23)

2.0 Patterns, Functions, and Algebra – Students know and understand various types of patterns and functional relationships. They use symbolic forms and models to represent and analyze mathematical structures in both real and abstract contexts.

2.1 Understand the properties of functions and their graphs: absolute value, polynomial, composite, exponential, logarithmic, rational, trigonometric, piece-wise, and greatest integer. (p/c)

- Find the inverse of a function. (c/aII2)
- Find the domain and range of a function. (p)
- Find the zeroes of functions using the appropriate method. (c/aII7)

- Understand the concept of a function being “odd”, “even”, or “neither” and the implied symmetry. (p)
 - Determine the end behavior and continuity of a function (i.e., find horizontal and vertical asymptotes). (c/C12)
 - Understand and use inequalities and graph them in terms of one or two variables. (c/aII2)
 - Know the definition of absolute value in piece-wise notation. (p)
- 2.2 Understand and apply the specific properties of polynomials.** (p/c/aII3)
- Find the zeroes and values of a polynomial function using the techniques of: synthetic division, rational root theorem, factor theorem, remainder theorem, factoring, quadratic formula, and technology. (c/aII7)
 - Find local maximums, minimums, and points of inflection using the derivative and technology. (c/aIII0)
- 2.3 Interpret solution sets of systems.** (c/C/la8/p)
- Solve equations with two, three, or four unknowns using the appropriate technique (i.e., graphing, elimination, Cramer’s rule, inverses, matrices, and technology). (c/la2.111)
 - Solve, graph, and understand characteristics of systems of linear equations with two or more variables. (p)
 - Solve inequalities involving various functions and conic sections. (c/ma5)
 - Write solutions in set notation form. (p)
 - Apply the notation of inverse to a square matrix. (la9)
- 2.4 Understand and use trigonometric identities and formulas.** (p/c)
- Apply ratio, reciprocal, and co-functions. (p)
 - Apply Pythagorean identities. (c/t3.1)
 - Apply sum, difference, double, and half-angle formulas for sine, cosine, and tangent. (p)
 - Verify trigonometric identities. (c/t3.2)
 - Solve trigonometric equations and inequalities algebraically and graphically. (p)
- 2.5 Understand how to use sequences and series.** (c2,3/p)
- Identify a sequence as arithmetic, geometric, or neither. (c/C1)
 - Be familiar with the notation for the limits of a sequence as the independent variable approaches a number or infinity. (c/C1)
 - Determine convergence or divergence of a sequence. (c/ma8)
 - Understand the convergence of a geometric series. (c/C2,3)
 - Give the explicit and recursive definition for the n th term of a sequence.
 - Use sigma notation to expand a series. (p)
 - Find the sum of a finite series if it exists. (p)
 - Find the sum of an infinite series using the sequence of partial sums. (p)
 - Use mathematical induction to prove that a statement is true (i.e., formulas for sums and squares of the first “ n ” integers). (p)
- 2.6 Understand functions and equations defined parametrically.** (c/ma7)

- 2.7 Know the algebraic and graphical interpretation of limit of values of functions.**
(c/C1.0/ma8)
- Explain one-sided limits, infinite limits, and limits at infinity. (c/C1.3)
 - Evaluate limits of sums, products, quotients, and composition of functions. (c/C1.1)
 - Use technology to verify and estimate limits. (c/C1.1)
- 2.8 Know the formal definition and graphical interpretation of continuity of a function.**
(c/C2)
- Classify discontinuity algebraically and graphically.
- 2.9 Understand and explain the concept of derivative of a function. ***
- Know the formal definition of derivative. (c/C4)
 - Differentiate elementary algebraic functions. (C6,4.3)
 - Apply the concept of derivative as an instantaneous rate of change. (c/C4.2)
 - Determine slope of a line tangent to a function. (c/C4)
 - Determine extrema and points of inflection. (c6/a)
 - Determine velocity and acceleration functions given position function. (c/C16)

3.0 Measurement – Students know and understand attributes, units, and systems of measurement. They apply a variety of techniques, tools, and formulas for determining measurements.

- 3.1 Select and use appropriate units and scales of measurement.** (p/s)
- 3.2 Convert between, or within various systems of measurement. ***
- Convert between English/metric.
 - Convert between Radian/degree. (c/t1)
- 3.3 Understand the relationship of function units as it relates to position, velocity, and/or acceleration.** (c/C16)

4.0 Geometry and Spatial Sense – Students know how to analyze characteristics and properties of two- and three- dimensional objects. They select and use different representational systems, including coordinate and graph theory. They understand the usefulness of transformations and symmetry in analyzing mathematical situations. They know how to visualize and to use spatial reasoning to solve problems that cross disciplines.

- 4.1 Demonstrate an understanding of the geometric interpretation of vectors in two and three dimensions.** (p)
- Interpret graphic representations.
 - Interpret magnitude and direction.
 - Interpret sum and different, resultant.
 - Interpret scalar multiples and parallel and perpendicular.

4.2 Understand and demonstrate the geometry of trigonometry.

- Solve triangle relationships using law of sine, law of cosine, area of all triangles, and angles of elevation and depression.
- Define sine and cosine as y and x coordinates of points on the unit circle.
- Compute the values of the six trigonometric functions at various standard points.
- Derive the three Pythagorean identities graphically.
- Define all six trigonometric functions and can graph them.
- Graph functions of the form $y=asinb(x+c)+d$ and $y=acosb(x+c)+d$ and interpret a , b , c , d in terms of amplitude, frequency, period, and horizontal or vertical shift.
- Define the inverse trigonometry functions and graph them.
- Demonstrate how the tangent of the angle that a line makes with the x axis is equal to the slope of the line.
- Use trigonometry to determine unknown sides and angles in triangles and understand how to determine if there is a unique triangle, no triangle at all, or the ambiguous case where two triangles are possible.

4.3 Transform the graphs of a function.

- Apply absolute value.
- Apply odd vs. even.

4.4 Use differentiation to sketch, by hand, graphs of functions. (c/C9)

- Identify maxima, minima, inflection points, and intervals where the function is increasing, decreasing, concave up, or concave down.

4.5 Interpret geometrically the solution sets of systems of equations.**4.6 Translate between polar and rectangular coordinates and understand these relationships graphically.****4.7 Be familiar with conic sections, both analytically and graphically. (c/C/aII16)**

- Take quadratic equations in two variables and put in graphing form by means of completing the square.
- Identify type of conic section given equation in form.
- Determine geometric components such as foci, asymptotes of conic sections translated off of the origin. (C/aII16)
- Derive an equation from a geometric representation of a conic section.
- Find the angle of rotation of a conic section.

4.8 Understand and apply the components of a graph of a function.

- Determine domain and range.
- Determine types of discontinuity.
- Evaluate limits.

5.0 Data Analysis, Statistics, and Probability – Students know how to pose questions and collect, organize, represent, and interpret data in order to answer those questions. They use methods of exploratory data analysis to develop and evaluate inferences, predictions, and arguments that are based on data. They understand and know how to apply the notions of chance and probability.

5.1 Organize, represent, and interpret data in graphs.

6.0 Problem Solving – Students know that they learn basic skills and concepts in order to use them to solve problems in and out of school. They solve routine and complex problems by drawing from a variety of strategies, including technology, while demonstrating an attitude of persistence and reflection in their approaches.

6.1 Make decisions about how to approach problems. (p9-12)

- Analyze problems by identifying relationships, discriminating relevant from irrelevant information, identifying missing information, sequencing and prioritizing information, and observing patterns.
- Identify and utilize appropriate tools.
- Make generalizations based on prior knowledge and related examples.

6.2 Apply one or more mathematical relations to solve mathematical and real world problems. (p/c)

- Apply polynomial functions/relations including linear, quadratic, higher degree, and systems. (C/aII2)
- Apply inequalities. (p)
- Apply exponential/logarithmic. (c/C4.4)
- Apply rational functions. (c/C19)
- Apply trigonometry including right triangle relationships and laws of cosines and sines. (c/t13)
- Apply absolute value. (c/aIII1)
- Apply matrices. (c10.4)
- Apply vectors. (c10.4)
- Apply sequences and series. (c/C23)
- Apply limits of continuity and derivatives. (c/C20)

6.3 Use calculators/computers to solve mathematical problems, model physical phenomenon, introduce new concepts, and verify conjectures. (p)

- Determine when the use of the calculator will be effective and efficient.
- Use calculators/computers to produce tables, graphs, and their components.
- Demonstrate how to translate between representations (i.e., table, equation, and graph).
- Determine if results from the calculator are reasonable and can verify their results.

7.0 Processes: Reasoning, Communication, and Connections – Students use reasoning to develop, analyze, draw conclusions, and validate conjectures and arguments. As they reason, they recognize and understand multiple representations of the same concept. They see the interconnections among math ideas, as well as in other disciplines. They know how to communicate their math thinking clearly and coherently to others, orally, graphically, and in writing, using precise language and symbols.

7.1 Communicate math thinking and conclusions using words, graphs, and charts. (p)

7.2 Demonstrate proofs of various formulas. (c/g2/ma3)

- Prove trigonometric formulas for sum, difference, double, and half-angled formulas for sine, cosine, and tangent. (c/t11)
- Prove the Pythagorean identities. (c/g14)
- Prove trigonometric formulas for area of any triangle, law of sines and laws of cosines. (c/t13)
- Prove DeMoivre's Theorem. (c/ma2)

7.3 Apply math skills to new situations. (p)

- Demonstrate interconnections among algebra, geometry, coordinate geometry, functions, data analysis, sequences, series, and vectors.
- Explain the method of Mathematical Induction and prove general statements about positive integers.
- Explain the Binomial Theorem and use it to expand binomial expressions.
- Judge the validity of an argument according to whether the properties of real numbers, exponents, and logarithms, have been applied correctly at each step. (c/aII25)
- Explain and apply the fundamental theorem of algebra. (c/ma4)
- Demonstrate the relationship between a sequence, a series, and how Sigma notation can connect them.

7.4 Be familiar with the formal definition of the derivative. (c/C4.0)

- Explain the application of the limit.
- Explain the relationship between continuity and differentiability.
- Explain the graphical interpretations.

7.5 Apply literacy skills when making mathematical connections. (p-language arts)

- Learn and use mathematics vocabulary encountered through reading. (R1.0)
- Use strategies to comprehend, analyze, and evaluate mathematics reading materials. (R2.0)
- Employ technology to organize and record mathematics information. (R3.0)
- Write about mathematics to convey ideas logically and correctly. (W2.0)