Wall Township Public Schools	Board Approval Date: 8/19/2024

Course Title: Precalculus CP

Course Description: The goal of this course is to expand and reinforce the ability to understand, manipulate, and apply continuous functions in a variety of situations. By examining problems from graphical, numerical, and algebraic perspectives this course will prepare students for calculus, statistics and higher mathematics. The course focuses on function families including polynomial, rational, logarithmic, and trigonometric functions. Conic sections are another topic of study. Graphing calculator use is emphasized. The use of technology is infused to gather, analyze, and communicate mathematical information.

New Jersey Student Learning Standards - Math

Vision for Mathematics Education in New Jersey

A New Jersey education in Mathematics builds quantitatively and analytically literate citizens prepared to meet the demands of college and career, and to engage productively in an information-driven society. All students will have access to a high-quality mathematics education that fosters a population that:

- leverages data in decision-making and as a lens for discussing, analyzing, and responding to practical questions.
- persists to make sense of and model problems arising in everyday life, society, and the workplace.
- thinks critically and strategically to assess quantitative relationships and to solutions to complex problems.
- employs precise reasoning and constructs viable arguments to deduce conclusions, recognize false statements and assess peers' reasoning.
- interprets, evaluates and critiques the mathematics embedded in social, scientific and commercial systems, as well as the claims made in the private and public sectors.
- communicates precisely when conveying, representing, and justifying both qualitative and quantitative perspectives.

Standards for Mathematical Practice*

The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important "processes and proficiencies" with longstanding importance in mathematics education. The first of these are the NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections. The second are the strands of mathematical proficiency specified in the National Research Council's report Adding It Up: adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently and appropriately), and productive disposition (habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy).

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

**See end of document for additional information related to the mathematical practices.*

Inclusion of Climate Change Opportunities

( ) notes opportunities to integrate specific examples of climate change education provided by additional age-appropriate resources

The goal of inclusion of climate change education implementation is to foster generations of New Jersey students that can analyze, question, interpret, to think independently, and bring critical deduction to fulfill, and to lead in jobs created by burgeoning industries of the future green economy.

Course Sequence & Pacing	
Unit Title	**Estimated Number of Instructional Periods**
Unit 1: Introduction to Functional Analysis	22
Unit 2: Analysis of Polynomial Functions	19
Unit 3: Analysis of Rational Functions	15
Unit 4: Analysis of Implicitly Defined Functions	16
Unit 5: Analysis of Exponential and Logarithmic Functions	21
Unit 6: Introduction to Trigonometric Functions	19
Unit 7: Analysis of Trigonometric Functions	23

Unit 1

Desired Results

Unit 1: Introduction to Functional Analysis

Unit Summary: Creating a graph is not the same as interpreting the information displayed. Graphs and equations are alternative ways of displaying relationships between real life situations.

Learning Standards

NJSLS Math:

- F.BF.A. Build a function that models a relationship between two quantities
  - b. Combine standard function types using arithmetic operations.
  - c. Compose functions.
- F.BF.B. Build new functions from existing functions
  - 3. Identify the effect on the graph of replacing by *k* and 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.
  - 4. Find inverse functions.
- F.IF. A. Understand the concept of a function and use function notation
  - 1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and *x* is an element of its domain, then *f(x)* denotes the output of *f* corresponding to the input *x*. The graph of is the graph of the equation .
  - 2.Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
- F.IF. C. Analyze functions using different representations
  - 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 linear and quadratic functions and show intercepts, maxima, and minima.
b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
6. Attend to precision
7. Look for and make use of structure

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

- 9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas
- 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving

Computer Science & Design Thinking (*CS & DT***):**

- Practice 2 Collaborating Around Computing and Design
    - Collaborative computing is the process of performing a computational task by working on pairs in teams. Because it involves asking for the contributions and feedback of others, effective collaboration can lead to better outcomes than working independently. Collaboration requires individuals to navigate and incorporate diverse perspectives, conflicting ideas, disparate skills, and distinct personalities. Students should use collaborative tools to effectively work together and to create complex artifacts. When engaging in this practice, students:
        - Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities.

- Create team norms, expectations, and equitable workloads to increase efficiency and effectiveness.
- Solicit and incorporate feedback from, and provide constructive feedback to, team members and other stakeholders. Evaluate and select technological tools that can be used to collaborate on a project.

Learning Targets

Unit Essential Questions:

- How are functions and their graphs related?
- How can technology be used to investigate properties of functions and their graphs?
- What information can be used from an equation to sketch a function?
- How can a function be manipulated and how does it affect its graph?

Unit Enduring Understandings:

- Graphs and equations are alternative ways for depicting and analyzing patterns of non-linear change.
- Mathematical models can be used to describe physical relationships; these are often non-linear.
- Creating a graph is not the same as interpreting the information displayed.
- A variety of families of functions and methods can be used to model and solve real world situations

Vocabulary: Parent functions, key characteristics, piecewise, transformation, zeros, domain, range, increasing, decreasing, relative extrema, odd function, even function, continuous, discontinuity, one-to-one, inverse function

Students will be able to:

- Graphs constant, linear, absolute value, quadratic, and radical functions and their shifts, reflections and/or stretches.
- Compute values of the domain and range graphically and analytically.

- Interpret graphs of functions identifying intervals of increasing, decreasing, and constant function values as well as comparing the function to F(x) = 0.
- Determine domain and range of a function graphically and analytically.
- Perform operations on functions, including the composition of functions numerically, graphically and analytically.
- Understand what it means for a function to be discontinuous and classify discontinuities as removable (point) or non-removable (jump or infinite).
- Classify functions as even, odd, or neither graphically and analytically.
- Determine if a function is a one-to-one function or not.
- If a function is a one-to-one function, find the inverse of a function numerically, graphically and analytically.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Scavenger hunts and communicator practice
- WSS-Operations on functions
- WSS-Inverses of functions numerically and analytically
- Suggested Activities
  - Cut & Paste Activity-Continuity of Functions
  - Scavenger Hunt-Operations & Continuity of Functions

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Communicators
- Quiz 1: Graphs

- Quiz 2: Functions
- Classwork

Summative Assessments:

- Cumulative Assessments

Common Benchmark Assessments:

- Common Unit Assessments

Alternative Assessments:

- Modified Unit Assessments
- Modified Projects
- Other Modified Assessments

Core Instructional & Supplemental Materials

- Math Ixl
- Deltamath
- Khan Academy

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:

Students receiving Special Education programming have specific goals and objectives, as well as accommodations and modifications outlined within their Individualized Education Plans (IEP) due to an identified disability and/or diagnosis. In addition to exposure to the general education curriculum, the instruction is differentiated based upon the student's needs. The IEP acts as a supplemental curriculum guide inclusive of instructional strategies that support each learner.

- Small group/One to one - Additional time - Review of directions - Student restates information - Space for movement or breaks - Extra visual and verbal cues and prompts - Preferential seating - Follow a routine/schedule - Rest breaks - Verbal and visual cues regarding directions and staying on task - Checklists - Immediate feedback
-Alternate or reduced work within Digital Platforms such as Math IXL

Specific Strategies and Practices that Support English Language Learners

English language learner (ELL) is a national-origin-minority student who is limited-English-proficient. This term is often preferred over limited-English-proficient (LEP) as it highlights accomplishments rather than deficits.

- Pre-teaching of vocabulary and concepts - Personal Glossary - Extended Time - Simplified/Verbal Instructions - Frequent Breaks - Visual learning, including graphic organizers - Use of cognates to increase comprehension - Teacher modeling - Pairing students with beginning English language skills with students who have more advanced English language skills - Scaffolding - Word walls - Think-pair-share - Cooperative learning groups
-Alternate or reduced work within Digital Platforms such as MathIXL

Students at Risk of Failure

- Home/School Connection - Alternative Assessments - Learning Contracts - Homogenous Grouping - Supplemental Instruction - Think-Pair-Share by Readiness - Homework Options - Differentiated Online Practice - Leveled Rubrics - Tiered Level of Supports - Tiered Activities - Small Group Instruction - Work Alone Choice - Group Work Choice
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Students with 504 Plans

Teachers are responsible for implementing designated services and strategies identified on a student's 504 Plan.
504 plans are formal plans that schools develop to give kids the support they need and covers any condition that limits daily activities in a major way. Students' accommodations are outlined in their individual 504 plan.

Specific Strategies and Practices that Support Gifted & Talented Students

It is critical that all teachers are able to recognize a high-ability student who may need more depth and complexity in instruction.

-Homogenous Grouping - Small Group In-Depth Instruction - Differentiated Online Practice - Alternative Assessments - Pre-Assess to provide Differentiated Instruction to Accelerate Learning
-Enrichment/Extension Activities within Digital Platforms such as MathIXL

Unit 2

Desired Results

Unit 2: Analysis of Polynomial Functions

Unit Summary: In this unit students will focus on polynomial functions of degree 3 or higher to identify end behavior and zeros of polynomial functions. Techniques will be presented for solving certain kinds of polynomial equations that will enhance students' abilities to manipulate algebraically the polynomial functions that model real world situations. Additionally, students will study methods for finding zeros of polynomial functions.

Learning Standards

NJSLS Math:

- A.APR. B. Understand the relationship between zeros and factors of polynomials
  - 2. Know and apply the Remainder Theorem: For a polynomial and a number , the remainder on division by is, so if and only if is a factor of .
  - 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.
- F.IF C. Analyze functions using different representations
  - 8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
5. Use appropriate tools strategically
6. Attend to precision

7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

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- 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving

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        - Solicit and incorporate feedback from, and provide constructive feedback to, team members and other stakeholders. Evaluate and select technological tools that can be used to collaborate on a project.

Learning Targets

Unit Essential Questions:

- How do the characteristics of graphs relate to their corresponding equations?
- How can algebra help us get information about a graph from an equation?
- How can the graph of a function be used to determine the essential characteristics of the function?
- What is the best method for graphing polynomials?
- How can technology assist in the understanding of graphing functions?

Unit Enduring Understandings:

- Functions can be written in many ways-some forms can be helpful under different circumstances.
- The vocabulary is just as important as the math.
- Functions families have common characteristics.
- We can use algebra to help graph functions
- Technology is a resource for discoveries and investigations.
- There is a difference between using technology to find the answer compared to using technology to aid in supporting the answer.

Vocabulary: End behavior, polynomials, zeros, multiplicity, degree, turning points, concavity, factored form, standard form, intercepts, long division, synthetic division, remainder theorem, factor theorem, rational roots theorem, real and complex zeros, conjugate pairs.

Students will be able to:

- Solve polynomial equations by factoring and make connections between the solutions and the graph of the function.
- Solve polynomial inequalities.
- Understand the graphical connection between the factors of a function and the zeros of the graph, including the multiplicity of those zeros.
- Sketch approximate graphs of polynomial functions using the zeros, the multiplicity of the zeros and end behavior.
- Review polynomial synthetic division and apply the Factor and Remainder Theorems for polynomial functions.

- Develop the Rational Root Theorem to identify all of the possible rational roots of a polynomial function.
- Find all roots, real and imaginary, by applying the Rational Roots Theorem of polynomial functions.
- Analyze polynomial functions numerically, graphically and analytically.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Scavenger hunts and communicator practice
- PTR-Factoring
- WSS-Solve polynomial equations and inequalities
- PTR-Synthetic Division
- Suggested Activities
  - Digital Pixel Activity-Identifying all real and complex zeros
  - Digital Progression Puzzle-Long and Synthetic Division
  - Scavenger Hunt-Mixed Polynomial Review
  - Task Cards-Rational Zero Theorem

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Communicators
- Quiz 1
- Quiz 2
- Quiz 3

- Classwork

Summative Assessments:

- Cumulative Assessments

Common Benchmark Assessments:

- Common Unit Assessments

Alternative Assessments:

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- Modified Projects
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Core Instructional & Supplemental Materials

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-Enrichment/Extension Activities within Digital Platforms such as MathIXL

Unit 3

Desired Results

Unit 3: Analysis of Rational Functions

Unit Summary: The unit continues with the study of rational functions and their graphs. Students will find the domain, explore limits, identify vertical and horizontal asymptotes, and use transformations to graph a rational function. Finally, students will learn the basic techniques for solving polynomial inequalities and use those techniques to solve inequalities involving rational functions.

Learning Standards

NJSLS Math:

- A-APR D. Rewrite rational expressions
  - 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.
- F.IF C. Analyze functions using different representations
  - 8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
- F.IF C. Analyze functions using different representations
  - d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them

5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
- 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving

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Learning Targets

Unit Essential Questions:

- How do the characteristics of graphs relate to their corresponding equations?
- How can algebra help us get information about a graph from an equation?
- How can the graph of a function be used to determine the essential characteristics of the function?
- How are horizontal asymptoptes connected to end behavior?
- How can technology assist in the understanding of graphing functions?

Unit Enduring Understandings:

- Functions can be written in many ways- some forms can be helpful under different circumstances.
- The vocabulary is just as important as the math. Functions families have common characteristics.
- We can use algebra to help graph functions.
- Technology is a resource for discoveries and investigations.
- There is a difference between using technology to find the answer compared to using technology to aid in supporting the answer.

Vocabulary: End behavior, zeros, multiplicity, factored form, intercepts, long division, synthetic division,real and complex zeros, vertical asymptotes, horizontal asymptotes, oblique asymptotes.

Students will be able to:

- Solve rational equations and inequalities.
- Discover graphical and analytical connections including restricted values, domain, and intercepts for rational functions.
- Discover properties of rational functions analytically including point discontinuities and vertical asymptotes.
- Determine equations of horizontal and slant asymptotes of rational functions.
- Develop graphs of rational functions.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Scavenger hunts and communicator practice
- PTR-Solving rational equations
- WSS-Solving rational inequalities

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Communicators
- Quiz 1
- Quiz 2
- Classwork

Summative Assessments:

- Cumulative Assessments

Common Benchmark Assessments:

- Common Unit Assessments

Alternative Assessments:

- Modified Unit Assessments
- Modified Projects
- Other Modified Assessments

Core Instructional & Supplemental Materials

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Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

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Students at Risk of Failure

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Unit 4

Desired Results

Unit 4: Analysis of Implicitly Defined Functions

Unit Summary: The study of conic sections is a combination of algebra and geometry. Defined as the intersection of a double napped right circular cone and a plane, each type of conic section can be represented as an equation in the Cartesian, and later, the polar plane. These conics (circles, ellipses, parabolas, and hyperbolas) are applied in real-world situations, such as relative distance from an epicenter, orbits of planets, flashlights, and satellites.

Learning Standards

NJSLS Math:

- G-GPE A. Translate between the geometric description and the equation for a conic section
  - 1. Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.
  - 2. Derive the equation of a parabola given a focus and directrix.
  - 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.

Standards for Mathematical Practice

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Interdisciplinary Connections

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Learning Targets	
Unit Essential Questions:	**Unit Enduring Understandings:**

• How are multiple representations of conic sections related and used to model real world situations? • How can the variable of time be incorporated into the coordinate plane?	• The characteristics of conic sections and their representations are useful in solving real-world problems.
Vocabulary: conic section, parabola, circle, ellipse, hyperbola, focus, directrix, major and minor axes, vertices	
Students will be able to: • Derive and apply the distance formula to solve problems in the coordinate plane. • Analyze the symmetry of graphs of implicitly defined equations. • Analyze implicitly defined equations whose graphs are circles and semi-circles. • Analyze implicitly defined equations whose graphs are ellipses. • Analyze implicitly defined equations whose graphs are hyperbolas.	

Learning Activities:
• Small Group
• Differentiation - Enrichment, Support, etc.
• Scavenger hunts and communicator practice
• PTR-Distance Formula
• Suggested Activities
  ○ Poster Activity-Personalized Parabolas
  ○ Task Cards-Hyperbolas
  ○ Emoji Graphing Activity
  ○ Stations-Identifying & Sketching conics and their characteristics	

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Communicators
- Quiz 1
- Quiz 2
- Classwork

Summative Assessments:

- Cumulative Assessments

Common Benchmark Assessments:

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- Pre-teaching of vocabulary and concepts - Personal Glossary - Extended Time - Simplified/Verbal Instructions - Frequent Breaks - Visual learning, including graphic organizers - Use of cognates to increase comprehension - Teacher modeling - Pairing students with beginning English language skills with students who have more advanced English language skills - Scaffolding - Word walls - Think-pair-share - Cooperative learning groups
-Alternate or reduced work within Digital Platforms such as MathIXL

Students at Risk of Failure

- Home/School Connection - Alternative Assessments - Learning Contracts - Homogenous Grouping - Supplemental Instruction - Think-Pair-Share by Readiness - Homework Options - Differentiated Online Practice - Leveled Rubrics - Tiered Level of Supports - Tiered Activities - Small Group Instruction - Work Alone Choice - Group Work Choice
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Students with 504 Plans

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Specific Strategies and Practices that Support Gifted & Talented Students

It is critical that all teachers are able to recognize a high-ability student who may need more depth and complexity in instruction.

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Unit 5

Desired Results

Unit 5: Analysis of Exponential and Logarithmic Functions

Unit Summary: In this unit of exponential and logarithmic functions, students will begin with the characteristics of exponential functions and their graphs, as well as use formulas for compound interest. They will continue with the study of logarithmic functions as the inverse function of exponential functions. At that point, students will learn the properties of logarithms to expand and condense logarithmic expressions, and then expand that understanding to exponential and logarithmic equations. Finally, students will apply their skills to modeling data with real world examples of exponential growth and decay

Learning Standards

NJSLS Math:

- A.SSE B. Write expressions in equivalent forms to solve problems
  - 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 can be rewritten as to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.
- F.IF C. Analyze functions using different representations
  - 7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
    - e. Graph exponential and logarithmic functions, showing intercepts and end behavior.
  - 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 , , , , and classify them as representing exponential growth or decay.

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure

Interdisciplinary Connections

Career Readiness, Life Literacies, & Key Skills *(CLKS)*:

- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
- 9.4.12.CI.3: Investigate new challenges and opportunities for personal growth, advancement, and transition
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving

Computer Science & Design Thinking (*CS & DT***):**

- Practice 2 Collaborating Around Computing and Design
  - Collaborative computing is the process of performing a computational task by working on pairs in teams. Because it involves asking for the contributions and feedback of others, effective collaboration can lead to better outcomes than working independently. Collaboration requires individuals to navigate and incorporate diverse perspectives, conflicting ideas, disparate skills, and distinct personalities. Students should use collaborative tools to effectively work together and to create complex artifacts. When engaging in this practice, students:
    - Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities.

- Create team norms, expectations, and equitable workloads to increase efficiency and effectiveness.
- Solicit and incorporate feedback from, and provide constructive feedback to, team members and other stakeholders. Evaluate and select technological tools that can be used to collaborate on a project.

Learning Targets

Unit Essential Questions:

- How can an exponential function represent a real-world scenario?
- How can the properties of logarithms be used to solve equations?
- Why does simplifying or expanding a logarithmic expression help us solve problems?

Unit Enduring Understandings:

- Functions families have common characteristics.
- We can use algebra to help graph functions. Knowing how to read an equation is essential for graphing the function.
- Mathematics applies to the sciences.

Vocabulary: Exponential function, transformations, e, logarithms, domain, expand, condense, growth, decay.

Students will be able to:

- Use the properties of exponents to solve exponential equations by rewriting both sides of the equation as a power of the same base. Investigate graphs and equations of exponential functions.
- Classify exponential functions as growth or decay functions.
- Graph exponential functions, identifying horizontal asymptotes and applying shifts and/or reflections to basic functions.
- Define a logarithm to be the inverse of an exponential and simplify simple logarithms using basic properties.
- Simplify complex logarithmic expressions applying all of the properties of logarithms.

- Develop graphs of logarithmic functions, identifying vertical asymptotes, domain, range, and end behavior graphically, analytically and numerically.
- Solve exponential and logarithmic equations using the inverse properties of logarithms and exponentials.
- Solve application problems involving exponential and logarithmic equations.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Scavenger hunts and communicator practice
- PTR-Properties of exponents
- WSS-Solving exponential and logarithmic equations
- Suggested Activities
  - Task cards-Exponential Function Applications
  - Math lib-Expanding & Condensing Logarithmic Expressions
  - Coloring Activity-Solving Logarithmic & Exponential Equations

Assessment Evidence

Formative Assessments:

- Warmup Quizzes
- Exit Quizzes
- Communicators
- Quiz 1
- Quiz 2
- Quiz 3
- Classwork

Summative Assessments:

- Cumulative Assessments

Common Benchmark Assessments:

- Common Unit Assessments

Alternative Assessments:

- Modified Unit Assessments
- Modified Projects
- Other Modified Assessments

Core Instructional & Supplemental Materials

- Math Ixl
- Deltamath
- Khan Academy

Accommodations and Modifications: Students with Disabilities, English Language Learners, Students at Risk of Failure, Students with 504s, Gifted & Talented Students

Specific Strategies and Practices that Support Students with Disabilities:

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Unit 6

Desired Results

Unit 6: Introduction to Trigonometric Functions

Unit Summary:

Trigonometric functions are essential in modeling periodic and oscillating behavior. This unit is designed to provide Euclidean and Cartesian, which are used in developing both a graphical and algebraic sense of trigonometric functions.

Learning Standards

NJSLS Math:

- F.TF A. Extend the domain of trigonometric functions using the unit circle
  - 1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle
  - 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.
  - 3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosines, and tangent for πx, $\pi+x$, and $2\pi-x$ in terms of their values for x, where x is any real number.
- F.TF B. Model periodic phenomena with trigonometric functions
  - 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.
- G.SRT C. Define trigonometric ratios and solve problems involving right triangles

- 6. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.
- Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

- G.SRT D. Apply trigonometry to general triangles
  - 9. (+) Derive the formula A = 1/2 ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.
  - 10. (+) Prove the Laws of Sines and Cosines and use them to solve problems.
  - 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).

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision

Interdisciplinary Connections

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- Solicit and incorporate feedback from, and provide constructive feedback to, team members and other stakeholders. Evaluate and select technological tools that can be used to collaborate on a project.

Learning Targets

Unit Essential Questions:

- When is it appropriate to use an estimated answer rather than an exact answer?
- Do patterns exist in trigonometry to better evaluate expressions?
- As a point travels around a circle, how do the angles formed relate to one another?
- When is one method of measuring an angle more appropriate than another method?

Unit Enduring Understandings:

- One representation may sometimes be more helpful than another; and, used together, multiple representations give a fuller understanding of a problem.
- Precalculus connects discrete pieces of mathematics from your past learning.
- Trigonometry allows for indirect measurement of triangles when given limited information.
- Patterns exist in trigonometry and can be used to simplify evaluative processes

Vocabulary: right triangle trigonometry, oblique triangle, degrees, radians, coterminal angles, reference angles, unit circle, law of sines, law of cosines

Students will be able to:

- Understand and apply the three basic trigonometric ratios to solve right triangles and application problems.
- Apply the Law of Sines and Law of Cosines to solve and find areas of oblique triangles and application problems.
- Find coterminal angle(s), reference angle, and convert to radians.
- Apply the six basic trigonometric ratios to find values for angles on the unit circle.
- Determine the value of the six trigonometric functions of a given angle not on the unit circle:
  - (1) knowing a point through which the terminal side of the angle passes, or
  - (2) given characteristics and constraints of the angle.
- Evaluate trigonometric functions of angles and solve simple trigonometric equations without the use of a calculator

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Scavenger hunts and communicator practice
- PTR-Right triangle trigonometry
- WSS-Evaluate trigonometric functions
- Suggested Activities
  - Coloring Activity-Trigonometric Ratios
  - Cut & Paste Activity-Finding Exact Trigonometric Values

Assessment Evidence

Formative Assessments:

- Warmup Quizzes

- Exit Quizzes
- Communicators
- Quiz 1
- Quiz 2
- Quiz 3
- Classwork

Summative Assessments:

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Alternative Assessments:

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Unit 7

Desired Results

Unit 7: Analysis of Trigonometric Functions

Unit Summary:

After developing a knowledge base for trigonometry, an in-depth algebraic and graphical study of trigonometric functions is examined in this unit. A major component of analytic trigonometry is solving and graphing equations involving trigonometric expressions. Algebraic relationships, such as inverses and identities, are explored for the purpose of solving these equations.

Learning Standards

NJSLS Math:

- F.TF.B Model periodic phenomena with trigonometric functions
  - 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.
- F.TF.C Prove and apply trigonometric identities
  - 8. Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$,or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.
  - 9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively

3. Construct viable arguments and critique the reasoning of others
5. Use appropriate tools strategically
6. Attend to precision

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Learning Targets

Unit Essential Questions:

- What does it mean when we solve a trigonometric equation?
- How do we represent multiple solutions on a given domain?
- What does it mean to prove an identity?
- How can we use identities to simplify the process involved in solving an equation?

Unit Enduring Understandings:

- The unit circle is a gateway between geometry and algebra.
- Context is critical when using estimation.
- Equivalent expressions can be written in a variety of formats.
- Algebra and proof can be used to verify trigonometric identities.

Vocabulary: Trig functions, sum and difference identity, double angle identities

Students will be able to:

- Use the nine basic trigonometric identities to rewrite expressions in terms of a single trigonometric ratio.
- Use the nine basic trigonometric ratios to prove that given equations are identities.
- Apply the trigonometric sum and difference identities.
- Apply the double angle trigonometric identities.
- Solve trigonometric equations, with and without technology.

Learning Activities:

- Small Group
- Differentiation - Enrichment, Support, etc.
- Scavenger hunts and communicator practice
- WSS-Double angle trigonometric identities
- WSS-Solve trigonometric equations
- Suggested Activities
    - Digital Google Form-Simplifying expressions using trigonometric identities

- Coloring Activity-Simplifying expressions using trigonometric identities
- Scavenger Hunt-Sum and Difference Identities
- Task Cards-Solving trigonometric equations

Unit 7 Stage 2 Assessment Evidence

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- Exit Quizzes
- Communicators
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- Quiz 2
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Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, “Does this make sense?” They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

2. Reason abstractly and quantitatively

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to *decontextualize*—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to *contextualize*, to pause as needed during the manipulation process to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

3. Construct viable arguments and critique the reasoning of others

Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases and can recognize and use

counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

4. Model with mathematics

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

5. Use appropriate tools strategically

Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically

proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

6. Attend to precision

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

7. Look for and make use of structure

Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7×8 equals the well-remembered$7 \times 5 + 7 \times 3$, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$ older students can see the 14 as $2 \times 7$and the 9 as $2 + 7$. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.

8. Look for and express regularity in repeated reasoning

Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $\frac{(y-2)}{(x-1)} = 3$.

Noticing the regularity in the way terms cancel when expanding $(x-1)(x+1)$, $(x-1)\left(x^2+x+1\right)$ and $(x-1)\left(x^3+x^2+x+1\right)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.