Course: PreCalculus Unit #3: Functions	Year of Implementation: 2025-2026

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Stage One - Desired Results

Link(s) to New Jersey Student Learning Standards for this course:
{provide all applicable links to standards here}
https://www.nj.gov/education/standards/

- **Unit Standards:** *(keep each of the following headings in place)*
  - ***Content Standards***
    - Standard: A-APR.B Understand the relationship between zeros and factors of polynomials
      - 2 Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

      - 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.

      - D. Represent and solve equations and inequalities graphically
      - 12 Graph the solutions to a linear inequality in two variables as a half plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

    - Standard: A.REI.A. Understand solving equations as a process of reasoning and explain the reasoning
      - 1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

B. Solve equations and inequalities in one variable
3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

4 Solve quadratic equations in one variable

Standard 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.

Standard: F-IF.B Interpret functions that arise in applications in terms of the context

4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity

5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function $h(n)$ gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.

Standard: F-IF.C Analyze functions using different representations
7e Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

9 Compare properties of two functions each represented in a different way (algebraically, graphically,

numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Standard: F-BF.A Build a function that models a relationship between two quantities
　　　1c Compose Functions

Standard: F-BF.B Build new functions from existing functions
　　　3. Identify the effect on the graph of replacing by f(x) by f(x) + k, kf(x), and f(x+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. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

　　　4 Find inverse functions.

- ○ *21st Century Life & Career Standards*
  - ■ All curriculum writers/revisionists need to include standards that apply to "Career Readiness, Life Literacies, and Key Skills". This should include a brief description of the standard and the standard number. Document only those standards and practices that apply to each unit. Use the following link to assist you [see pages of 31-36; 41-42; 53-56 for specific standard #'s and strands] https://www.state.nj.us/education/cccs/2020/2020%20NJSLS-CLKS.pdf

    - ● 9.4.12.CT.2 Explain the potential benefits of collaborating to enhance critical thinking and problem solving.
    - ● 9.4.12.CI.1 Demonstrate the ability to reflect, analyze, and use creative skills and ideas.
    - ● 9.4.12.TL.3 Analyze the effectiveness of the process and quality of collaborative environments.

- ○ *Interdisciplinary Content Standards*
  - ■ 8.2.12.EC.3 Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.

- ○ **NJ Statutes:** NJ State law mandates the inclusion of the following topics in lesson design and instruction as aligned to elementary and secondary curriculum.

  Amistad Law: N.J.S.A. 18A 52:16A-88 Every board of education shall incorporate the information regarding the contributions of African-Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.

  Holocaust Law: N.J.S.A. 18A:35-28 Every board of education shall include instruction on the Holocaust and genocides in an appropriate place in the curriculum of all elementary and secondary school pupils. The instruction shall further emphasize the personal responsibility that each citizen bears to fight racism and hatred whenever and wherever it happens.

  LGBT and Disabilities Law: N.J.S.A. 18A:35-4.35 A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards (N.J.S.A.18A:35-4.36) A board of education shall have policies and procedures in place pertaining to the selection of instructional materials to implement the requirements of N.J.S.A. 18A:35-4.35.

  Diversity and Inclusion (N.J.S.A. 18A:35-4.36a) A board of education shall incorporate instruction on diversity and inclusion in an appropriate place in the curriculum of students in grades kindergarten through 12 as part of the district's implementation of the New Jersey Student Learning Standards.

  Asian American and Pacific Islanders (AAPI) P.L.2021, c.410 Ensures that the contributions, history, and heritage of Asian Americans and Pacific Islanders (AAPI) are included in the New Jersey Student Learning Standards (NJSLS) for Social Studies in kindergarten through Grade 12 (P.L.2021, c.416)

For additional information, see

NJ Amistad Curriculum: https://www.nj.gov/education/amistad/about/

Diversity and Inclusion: https://www.nj.gov/education/standards/dei/index.shtml

- *(Sample Activities/ Lessons): https://www.nj.gov/education/standards/dei/samples/index.shtml*

Asian American and Pacific Islanders:

- **Asian American and Pacific Islander Heritage and History in the U.S.**

  A Teacher's Guide from EDSITEment offering a collection of lessons and resources for K-12 social studies, literature and arts classrooms that center around the experiences, achievements and perspectives of Asian Americans and Pacific Islanders across U.S. history.

Transfer Goal: Students will be able to independently use their learning to model and analyze various situations.

As aligned with LRHSD Long Term Learning Goal(s):https://www.lrhsd.org/academics/program-of-studies/curriculum

1. Problem-Solving: apply and transfer autonomously and collaboratively mathematical concepts and problem- solving techniques to unfamiliar, varied and real-world situations
2. Reasoning: reason abstractly and quantitatively by applying mathematical representations, symbols and estimation techniques when engaging in problem-solving
3. Critical Thinking: construct and effectively communicate valid conclusions and critique the reasoning of others
4. Modeling: demonstrate mastery of concepts by evaluating models that others have constructed or by creating appropriate models of their own
5. Tools: identify the correct tools to solve problems, if applicable
6. Precision: determine an answer's appropriateness as a means of determining its validity, while using proper mathematical notation and units
7. Structure: use multiple representations, critical thinking skills, and prior knowledge to solve problems in new situations
8. Patterns: analyze data and recognize patterns in a variety of situations
9. Habits of Mind: approach new situations with curiosity, persistence, resourcefulness, and confidence; take risks, monitor their progress, accept and learn from setbacks, make adjustments, and reflect on their performance.

Enduring Understandings	*Essential Questions*

EU 1 solving equations involving functions enables us to uncover and interpret the relationships between variables, providing deeper insights into the mathematical patterns and principles that govern real-world phenomena. *EU 2* properties and behaviors of functions allows us to create accurate mathematical models of real-world situations, enabling us to analyze, predict, and solve complex problems across various contexts.	● How can we solve equations involving functions, and what do the solutions reveal about the relationships and interactions between different variables? ● How can we use functions to model and analyze real-world situations, and what do their properties tell us about the behavior of these scenarios?
Knowledge *Students will know . . .* *EU 1* ● algebraic and numeric procedures are interconnected and build on one another to produce a coherent whole. (A-APR.B.2-3, F-IF.C.9, A.REI.A.1,2, A.REI.B.3-4, A.SSE.B.a-c) ● finding the inverse of a function helps to analyze the effects of domain over range and vice versa. (F.BF.B.3-4) ● rules of arithmetic and algebra can be used together with (the concept of) equivalence to transform equations and inequalities so solutions can be found to solve problems. (A-APR.B.2-3, F-IF.C.9, A.REI.A.1,2, A.REI.B.3-4, A.SSE.B.a-c) *EU 2*	*Skills* *Students will be able to. . .* *EU 1* ● apply the appropriate symbols or rules to simplify or solve exponential expressions/equations, logarithmic expressions/equations, rational expressions/equations, quadratic expressions/equations. (A-APR.B.2-3, F-IF.C.9, A.REI.A.1,2, A.REI.B.3-4, A.SSE.B.3) ● create appropriate test intervals to solve polynomial, rational and absolute value inequalities. (A.SSE.B.3a, A-APR.D.12) ● construct combinations and compositions of functions and identity domains of each. (F.BF.A.1, F.BF.B.3-4) ● find and verify inverses of functions algebraically and graphically and interpret their domains. (F-BF.B.4) *EU 2*

- the underlying structure of the Cartesian coordinate systems of mathematics relates to the interplay between graphical and algebraic representations. (F-IF.B.4-5, F-IF.C.7, A.APR.B.3, F.BFB.3, 4,5)
- functions can be analyzed algebraically and graphically for continuity and discontinuity, end behaviors, finding graphical intercepts and identifying domain and range. (F-IF.B.4-5, F-IF.C.7, A.APR.B.3, F.BFB.3, 4,5)
- piecewise functions and absolute value functions can be analyzed algebraically to identify domain, range, and discontinuities. (F.IF.C.7b)

- graph and analyze the 12 basic functions including polynomial functions of higher degrees. (F-IF.B.4-5, F-IF.C.7, A.APR.B.3)
- interpret transformations and characteristics of any function. (F.BFB.3)
- construct proper limit notation to describe characteristics of all graphs. (F.IF.B.4,5)
- construct and interpret absolute value functions as piecewise functions.(F.IF.C.7b)

Stage Two - Assessment

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Stage Three - Instruction

Learning Plan: **Suggested Learning Activities to Include Differentiated Instruction and Interdisciplinary Connections: Each learning activity listed must be accompanied by a learning goal of A= Acquiring basic knowledge and skills, M= Making meaning and/or a T= Transfer.** *{place A, M and/or T along with the applicable EU number in parentheses after each statement} All knowledge and skills must be addressed in this section with a corresponding lesson/activity which teaches each concept. The following color codes are used to notate activities that correspond with interdisciplinary connections and 21st Century Life & Career Connections (which involves Technology Literacy):*
Red = Interdisciplinary Connection; Purple = 21st Century Life & Career Connection

- Activity Future Value vs Present Value (T, EU 1)
  Annuitites WS.pdf
- Miscellaneous Functions Open Middle Questions (M,T, EU1)
  Copy of High School Open Middle Slides - Functions
- Which one Doesn't Belong, graphs (T, EU2)
  Copy of WODB - Graphs 1 - 42 (ALL)
- Iphone Opening Sales Desmos Activity (M, EU 2)
  https://teacher.desmos.com/activitybuilder/custom/561d6a780784861e06c3a6d5?collections=651ca31cf69ee59aa9e3818a,5da649ac6254f22e20fd1107
- Piecewise Functions Desmos Activity (M, EU 2)
  https://teacher.desmos.com/activitybuilder/custom/57d6b323d5b6478408b8748b?collections=651ca31cf69ee59aa9e3818a,5da6476150c0c36a0caf8ffb
- Mocha Modeling Desmos Activity for Functions (T, EU 2)
  https://teacher.desmos.com/activitybuilder/custom/564d37a2895eb8280b0bfe0d?collections=651ca31cf69ee59aa9e3818a,5e73b3a1bb8b0c7628d2809c
- Polygraph: Rationals (M,T,EU2)
  https://teacher.desmos.com/activitybuilder/custom/6019903a671f894659d4d463?collections=601980ced441a40d2179ea77

- 12 Basic Functions Card Sort (A,M, EU 2)
  Copy of 1a - 12 Basic Functions Stamp Sheet.pdfCopy of 1a - Twelve Basic Functions - Posters.pdfCopy of 1a -Twelve Basic Functions - Challenges (1).pdf

Suggested Sequence of Learning Activities

- Solve polynomial equations by factoring, synthetic division and quadratic formula. (A, EU 1)
- Apply the remainder and factor theorems to find zeros of polynomials. (M, EU 1)
- Find the polynomial function given the zeros and degree. (M, EU 1)

- Solve exponential equations (A, EU 1)
- Activity Future Value vs Present Value (T, EU 1)
- Apply properties of logs to simplify, evaluate, expand and condense (M, T EU 1)
- Solve log equations, checking for extraneous solutions. (A, M, EU 1)
- Solve rational equations, checking for extraneous solutions (A, EU 1)
- Solve absolute value inequalities. Write answers in interval notation. (A, EU 1)
- Solve polynomial inequalities. Write answers in interval notation. (A, M EU 1)
- Solve rational inequalities. Write answers in interval notation. (A, M, EU 1)
- Activity Miscellaneous Functions Open Middle Questions (M,T, EU1)
- Write the domain of a function in interval notation. (A, M, EU 2)
- Evaluate combinations and composition of functions algebraically and graphically, including domains of each. (A, M, T EU 2)
- Find and verify the inverse of a function, if it exists. (A, M, EU 2)
- Activity Which one Doesn't Belong, graphs (A, M, T, EU2)
- Terminology and characteristics of functions (continuity, boundedness, increasing/decreasing, max/min, even/odd symmetry, end behavior using limit notation, asymptotes, domain and range) (A, M, EU 2)
- Characteristics of the 12 Basic Functions (M, EU 2)
- 12 Basic Functions Card Sort (M, EU 2)
- Mocha Modeling Desmos Activity for Functions (T, EU 2)
- Transformations including vertical/horizontal shifts, vertical/horizontal stretches/shrinks, reflections over x-axis/y-axis (M, T, EU 2)
- Iphone Opening Sales Desmos Activity (M, EU 2)
- Write, sketch and analyze piecewise functions using 12 basic functions. (A, M, T EU 2)
- Piecewise Functions Desmos Activity (M, EU 2)
- Graph polynomial functions of higher degree finding the multiplicity at the zeros and end behavior using limit notation. (A, M, EU 2)
- Graph rational functions find holes, asymptotes (vertical and non-vertical), and end behavior all using proper limit notation. (A, M, EU 2)
- Activity Polygraph: Rationals (T,EU2)

Pacing Guide
{This chart will be identical in all of the units for this course.}

Unit #	Title of Unit	Approximate # of teaching days
1	Conics	12
2	Trigonometry	56
3	Functions	57
4	Limits	10

Instructional Materials

TI-Nspire Calculator
DESMOS online graphing calculator and activities
Khan Academy
Kuta Infinite Software

Accommodations

Special Education: The curriculum will be modified as per the Individualized Education Plan (IEP). Students will be accommodated based on specific accommodations listed in the IEP.

Students with 504 Plans: Students will be accommodated based on specific accommodations listed in the 504 Plan.

English Language Learners: Students will be accommodated based on individual need and in consultation with the ELL teacher.

Students at Risk of School Failure: Students will be accommodated based on individual need and provided various structural supports through their school.

Gifted and Talented Students: Students will be challenged to enhance their knowledge and skills through acceleration and additional independent research on the subject matter.