Course: *Algebra II Functions* **Unit #1:** *Quadratic Functions*	**Year of Implementation:** 2024-2025

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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.state.nj.us/education/cccs/2020/

- **Unit Standards:** *(keep each of the following headings in place)*
  - ***Content Standards***

The Complex Number System N -CN

A. Perform arithmetic operations with complex numbers.

1. Know there is a complex number i such that $i^2 = –1$, and every complex number has the form a + bi with a and b real.

2. Use the relation $i^2 = –1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

C. Use complex numbers in polynomial identities and equations.

7. Solve quadratic equations with real coefficients that have complex solutions.

8. (+) Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x – 2i)$.

9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

Seeing Structure in Expressions A-SSE

A. Interpret the structure of expressions

1. Interpret expressions that represent a quantity in terms of its context.

a. Interpret parts of an expression, such as terms, factors, and coefficients.

2. Use the structure of an expression to identify ways to rewrite it.

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.

a. Factor a quadratic expression to reveal the zeros of the function it defines.

b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

Arithmetic with Polynomials and Rational Expressions A -APR

B. Understand the relationship between zeros and factors of polynomials

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.

Creating Equations A -CED

A. Create equations that describe numbers or relationships

2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.

Reasoning with Equations and Inequalities 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.

B. Solve equations and inequalities in one variable

4. Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.

b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.

C. Solve systems of equations

7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.

D. Represent and solve equations and inequalities graphically

10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

11. Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

Interpreting 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 f is the graph of the equation $y = f(x)$.

2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

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.

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.

8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

Building Functions F-BF

B. Build new functions from existing functions

3. Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.

- ***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.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3)
    - 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8)
    - 9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
    - 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task (e.g., W.11-12.6.).

- ***Interdisciplinary Content Standards***

- SL.11-12.1. Initiate and participate effectively in a range of collaborative discussions (one-on- one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
- SL.11-12.4 Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.
- L.11-12.6. Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

- ***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 interpret different models to effectively communicate their reasonings.

As aligned with LRHSD Long Term Learning Goal(s):https://www.lrhsd.org/Page/6163

Reasoning: Students will be able to reason abstractly and quantitatively by applying mathematical representations, symbols and estimation techniques when engaging in problem solving.

Structure: Students will be able to use multiple representations, critical thinking skills and prior knowledge to solve problems in new situations.

Enduring Understandings Students will understand that. . . *EU 1*	*Essential Questions* What real world phenomena can be modeled using quadratics?

the symbolic language and critical vocabulary of Algebra and algebraic modeling are necessary to communicate, analyze, and generalize patterns and relationships in the real world. *EU 2* symbolic statements can be manipulated to provide equivalent forms and to model real world phenomena.	How is critical vocabulary utilized to communicate information provided in a quadratic function?
<u>Knowledge</u> *Students will know . . .* *EU 1* ● absolute value and quadratic functions can be graphed,transformed and model real-world situations. (A-CED A2, F-IF C7a,b, 8a, 9, F-BF B3) ● every function has a domain and range expressed in mathematical notation. (F-IF A1,2, B4,5) ● the critical points of a function's graph provide information about real world phenomena. (F-IF C7a,b, 8a, 9) ● the meaning of a complex number. (N-CN A1) ● complex numbers should be simplified using order of operations. (N-CN A2) ● complex zeros come in conjugate pairs. (N-CN A3, C8) ● the solutions to a system represent shared points. (A-CED A3, A-REI C7, D10,11) *EU 2* ● quadratic functions can be written and solved in various forms to provide different characteristics of the graph. (A-SSE A1a,2, B3a,b, A-APR B3, A-REI A1, B4a,b) ● quadratic functions can provide real and complex solutions. (N-CN C7,C9)	*<u>Skills</u>* *Students will be able to. . .* *EU 1* ● write the domain and range in interval notation of any function from its graph. (F-IF A1,2, B4,5) ● graph an absolute value function. (F-IF C7b) ● graph a quadratic function from standard, intercept, and vertex forms. (A-APR B3, A-CED A2, F-IF C7a, 8a, 9) ● describe how changing the key characteristics of the function transform the parent function. (F-BF B3) ● simplify radical expressions (real and imaginary). (N-CN A1) ● add, subtract, multiply, and simplify complex numbers. (N-CN A1,2) ● utilize the conjugate of a complex number in dividing and simplifying expressions. (N-CN A3, C8) ● solve a system of quadratic and linear equations graphically & algebraically. (A-CED A3, A-REI C7, D10,11) ● demonstrate the correct usage and application of critical vocabulary. (N-CN A1, A-SSE A1a, F-IF A1,2, B4,5, F-IF C7a,b, 8a, 9) *EU 2* ● change forms and find all zeros (real and complex) of a quadratic function by graphing, factoring,taking square

	roots, completing the square, using the quadratic formula, and using graphing technology. (N-CN C7, A-SSE A1a,2 B3a,b, A-REI A1, B4a,b, F-IF 8a) ● translate and solve quadratic functions to model real-world phenomena. (A-CED A2) ● recognize the relationship of the roots of a quadratic function to the x-intercepts of the graph. (N-CN C9, A-APR B3, F-IF 8a)
Stage Two - Assessment	
●	
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*

- *Desmos Activity, Finding Domain & Range from a Graph (A, M, T, EU 1)*
  https://teacher.desmos.com/activitybuilder/custom/56e8442cc2a23ba41da1c7d9?collections=5e8daca7ba47980c870d2e02
- *3-Act Task - Will it Hit the Hoop (A, M, EU 1)*
  https://blog.mrmeyer.com/2016/updated-will-it-hit-the-hoop/
- *Desmos Activity, Imaginary Numbers (A, EU 1)*
  https://teacher.desmos.com/activitybuilder/custom/60ba38f3aba06408a548b273
- *Desmos Activity, Transformation of Quadratic Functions (A, M, EU 1 & 2)*
  https://teacher.desmos.com/activitybuilder/custom/5c7614041509d870d4838bfd
- Numb3rs Blackout Activity, see link (M, T, EU1, EU2)
  https://drive.google.com/file/d/1q0mC_jYDTU1DSpiNu_D2QEeZ2knUnGQr/view?usp=sharing
- *Catapult Activity (M, T, EU 1 & 2)*
  https://docs.google.com/document/d/1OpXDzJCtjWI_gnQ7YUyIvnJh3BBOXRvTbzy_fv5ubmw/edit?usp=sharing

Suggested Sequence of Learning Activities:

- Critical Vocabulary, see below (A, EU 1)
- Domain and Range Activity, linked above *(A, M, T, EU 1)*
- *Will it Hit the Hoop, link above (A, M, EU 1)*
- graph absolute value functions from vertex form (A, EU 1)
- graph quadratic functions from vertex form (A, EU1)
- graph quadratic functions from standard form (A, EU 1)
- determine how changing a quadratic equation affects a real-world problem (M, T, EU 2)

- solve quadratic equations by factoring and write the solutions as zeros (x,0) (A, M, EU 2)
- graph quadratic functions from intercept form (T, EU1, EU2)
- *Imaginary Numbers Introduction, link above (A, EU 1)*
- solve for real and imaginary solutions by square roots (A, EU2)
- solve by square root and completing the square (A, EU2)
- solve and find the zeros using the quadratic formula & the discriminant (A, EU2)
- *Super Mario: Transformation of Quadratic Functions, linked above (A, M, EU 1 & 2)*
- solve a system of linear and quadratic equations (A, EU2)
- graph quadratic inequalities, solve a system of quadratic and linear inequalities (A, EU2)
- Numb3rs Blackout Activity, see link (M, T, EU1, EU2)
- *Catapult Activity, linked above (M, T, EU 1 & 2)*

Critical Vocabulary:

Axis of symmetry	Binomial	Coefficient	Complete the Square	Complex Number
Critical Point	Degree	Discriminant	Domain, Range	Factor Completely
Intercept Form	Imaginary	Maximum, Minimum	Monomial	Parabola
Parent Quadratic Function	Perfect Square	Polynomial	Quadratic Equation	Quadratic Formula
Quadratic Function	Roots, Solutions	Standard Form	Trinomial	Vertex
Vertex Form	X-Intercept	Y-Intercept	Zeros	

Pacing Guide

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

Unit #	*Title of Unit*	*Approximate # of teaching days*
1	Unit 1 Quadratic Functions	30
2	Unit 2 Polynomial Functions	18
3	Unit 3 Exponential & Logarithmic Functions	18
4	Unit 4 Radical Functions	18
5	Unit 5 Rational Functions	18
6	Unit 6 Functions	14
7	Unit 7 Statistics & Probability	18

Instructional Materials

TInSpire 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.