Unit 2
Quadratic Functions

Algebra II

Unit Description:

In this unit, students write the equations of quadratic functions to model situations and then graph these functions. A variety of methods will be used to solve quadratic equations and to graph quadratic functions. Students will interpret key features of the graphs and other parabolas. In the process, students learn about complex numbers.

Standards for Mathematical Practice

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

Louisiana Student Standards for Mathematics (LSSM)

The Louisiana Student Standards for Mathematics (LSSM), designates the following standards as A2: Algebra 2.
Italicized standards are designated as A1: Algebra 1 and are considered prerequisite standards for Algebra 2.
While these prerequisite standards are present in the curriculum for scaffolding purposes, teachers will focus instruction on Algebra 2 expectations.

F-IF: Interpreting Functions	
B. Interpret functions that arise in applications in terms of the context.	
F-IF.B.4	For linear, piecewise linear (to include absolute value), quadratic, and exponential functions that model 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; and end behavior. ★
F-IF.B.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. ★
C. Analyze functions using different representations.	
F-IF.C.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.
A-REI: Reasoning with Equations and Inequalities	
B. Solve equations and inequalities in one variable	
A-REI.B.4	Solve quadratic equations in one variable. **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.	
A-REI.C.7	Solve a simple system consisting of **a linear equation and a quadratic equation** in two variables algebraically and graphically. For example, find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$.
D. Represent and solve equations and inequalities graphically.	
A-REI.D.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. ★
A-SSE: Algebra-Seeing Structure in Expressions	
A. Interpret the structure of expressions	
A-SSE.A.1	Interpret expressions that represent a quantity in terms of its context. ★ **a.** Interpret parts of an expression, such as terms, factors, and coefficients. **b.** Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)^n$ as the product of P and a factor not depending on P.
F-BF: Building Functions	
B. Build new functions from existing functions	
F-BF.B.3	Identify the effect on the graph of replacing $f(x)$ by $f(x) \pm \boldsymbol{k}$, $\boldsymbol{k}\, f(x)$, $f(\boldsymbol{k}x)$, and $f(x \pm \boldsymbol{k})$ 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. Include recognizing even and odd functions from their graphs and algebraic expressions for them.
N-CN: The Complex Number System	
A. Perform arithmetic operations with complex numbers	
N-CN.A.1	Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a \pm bi$ with a and b real.

N-CN.A.2	Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.
C. Use complex numbers in polynomial identities and equations.	
N-CN.C.7	Solve quadratic equations with real coefficients that have complex solutions.
A-CED: Creating Equations	
A. Create equations that describe numbers or relationships	
A-CED.A.1	Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. ★
Additional Standards for Honors Classes **N-CN.C.8 (+)** Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$.	

★As defined by LSSM, the basic modeling cycle involves:
1. identifying variables in the situation and selecting those that represent essential features,
2. formulating a model by creating and selecting geometric, graphical, tabular, algebraic, or statistical representations that describe relationships between the variables,
3. analyzing and performing operations on these relationships to draw conclusions,
4. interpreting the results of the mathematics in terms of the original situation,
5. validating the conclusions by comparing them with the situation, and then either improving the model or, if it is acceptable,
6. reporting on the conclusions and the reasoning behind them.

Choices, assumptions, and approximations are present throughout this cycle.

Enduring Understandings:
- Quadratic functions are used to model a variety of real-world phenomena.
- Imaginary numbers exist so that negative numbers can have square roots and certain equations can be solved.
- Imaginary numbers have significant technological applications, particularly in the fields of electronics and engineering.

Essential Questions:
- What are the key features of a parabola?
- How do the parts of a transformation affect the parent function of a quadratic?
  - $y = x^2$
  - $y = a[b(x \pm h)]^2 \pm k$
- What are the parts of a complex number?