Unit Title	Functional Form and Design		**Length of Unit**	4 weeks
Focusing Lens(es)	Structure	**Standards and Grade Level Expectations Addressed in this Unit**	MA10-GR.HS-S.1-GLE.2 MA10-GR.HS-S.2-GLE.1 MA10-GR.HS-S.2-GLE.2 MA10-GR.HS-S.2-GLE.4	
Inquiry Questions (Engaging-Debatable):	• Why are functions necessary to the design and building of skyscrapers? (MA10-GR.HS-S.2-GLE.1-IQ.7)			
Unit Strands	Number and Quantity: Quantities Algebra: Reasoning with Equations and Inequalities Functions: Interpreting Functions Functions: Building Functions Functions Linear, Quadratic, and Exponential Models Personal Financial Literacy			
Concepts	systems of functions, non-linear, linear, classes of functions, operations, constants, average rate of change, increase, decrease, interval			

Generalizations **My students will Understand that…**	**Guiding Questions** **Factual**	**Conceptual**
Systems of non-linear functions create solutions more complex than those of systems of linear functions. (MA10-GR.HS-S.2-GLE.4-EO.d, e)	What do the solutions of a system of nonlinear functions represent in a context? How many solutions could exist for a system involving a circle and linear function? How do you know if a given point is a solution of a given system?	Why are solving systems of nonlinear functions different than systems of linear functions? Why are systems of equations used to model a situation?
New classes of functions emerge by performing operations on a function with constants and/or another function. (MA10-GR.HS-S.2-GLE.1-EO.d.i.2, e.i, ii)	What type of function is created when multiplying two linear functions? How can a table, graph, and function notation be used to explain how one function family is different or similar to another? (MA10-GR.HS-S.2-GLE.1-IQ.2)	How is the effect on a graph different when operating on a function with a constant versus another function? How can you operate on linear functions to create other classes of functions?

Mathematicians compare average rates of change over a specified interval to determine the increase or decrease of a function relative to another function. (MA10-GR.HS-S.2-GLE.1-EO.b.iii)	How do you calculate average rate of change? How does the average rate of change impact the behavior of a function over the entire span of the function?	How is the average rate of change represented in the graph and table of a function?
The modeling of nonlinear relationships between two quantities requires the use of appropriate functions. (MA10-GR.HS-S.2-GLE.1-EO.a, d) and (MA10-GR.HS-S.2-GLE.2-EO.a, b)	How can you determine from a table or context, which function models the relationship between two quantities? How can you determine the key features of a graph of a nonlinear function from its equation? How can you model a sequence with an equation? What are the differences between a linear function and an arithmetic sequence with the same parameters, algebraically and graphically? What phenomena can be modeled with particular functions? (MA10-GR.HS-S.2-GLE.2-IQ.2)	How do you use the key features of families functions to determine the appropriate function for given situation? Why are sequences functions? Why are sequences used to model situations? How can knowing whether or not a function is even or odd be useful? Why do we classify functions? (MA10-GR.HS-S.2-GLE.2-IQ.1)
Inverse functions facilitate the efficient computation of inputs of the original function. (MA10-GR.HS-S.2-GLE.1-EO.e.iii)	What is the relationship of the graph of an its inverse? When is it necessary to limit the domain of an inverse function?	How do inverses functions expand our understanding of an original function? Why are inverses important in mathematical modeling?

Key Knowledge and Skills: **My students will…**	*What students will know and be able to do are so closely linked in the concept-based discipline of mathematics. Therefore, in the mathematics samples what students should know and do are combined.*

- Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse. (MA10-GR.HS-S.2-GLE.1-EO.e.iii)
- Solve systems of linear equations limited to 3x3 systems exactly and approximately, focusing on pairs of linear equations in two variables. (MA10-GR.HS-S.2-GLE.4-EO.d.ii)
- Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. (MA10-GR.HS-S.2-GLE.4-EO.d.iii)
- 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 and include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. (MA10-GR.HS-S.2-GLE.4-EO.e.ii)
- Determine an explicit expression, a recursive process, or steps for calculation from polynomial, exponentials, logarithmic and trigonometric contexts. (MA10-GR.HS-S.2-GLE.1-EO.d.i.1)
- Combine polynomial, exponentials, logarithmic and trigonometric functions using arithmetic operations. (MA10-GR.HS-S.2-GLE.1-EO.d.i.2)
- Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms. (MA10-GR.HS-S.2-GLE.1-EO.d.ii)
- Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. (MA10-GR.HS-S.2-GLE.1-EO.a.iii)
- Identify the effect on the graph for polynomial, exponentials, logarithmic and trigonometric functions 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 and experiment with cases and illustrate an explanation of the effects on the graph using technology.

(MA10-GR.HS-S.2-GLE.1-EO.e.i, ii)

- For polynomial, exponentials, logarithmic and trigonometric functions, 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. (MA10-GR.HS-S.2-GLE.1-EO.b.i)
- Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval and estimate the rate of change from a graph for polynomial, exponentials, logarithmic and trigonometric functions. (MA10-GR.HS-S.2-GLE.1-EO.b.iii)
- Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions) for polynomial, exponentials, logarithmic and trigonometric functions. (MA10-GR.HS-S.2-GLE.1-EO.c.v.3)
- Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table). (MA10-GR.HS-S.2-GLE.2-EO.a.ii)
- Interpret the parameters in a linear or exponential function in terms of a context. (MA10-GR.HS-S.2-GLE.2-EO.b.i)
- Define appropriate quantities for the purpose of descriptive modeling. (MA10-GR.HS-S.1-GLE.2-EO.a.ii)
- Fit a function to data; use functions fitted to data to solve the problems in the context of the data.
- Find inverse functions by solving an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. (MA10-GR.HS-S.2-GLE.1-EO.e.iii)

Critical Language: includes the Academic and Technical vocabulary, semantics, and discourse which are particular to and necessary for accessing a given discipline. EXAMPLE: A student in Language Arts can demonstrate the ability to apply and comprehend critical language through the following statement: *"Mark Twain exposes the hypocrisy of slavery through the use of satire."*	
A student in _____ can demonstrate the ability to apply and comprehend critical language through the following statement(s):	*I know when solving a system of equations involving a circle and a linear function there may be one, two or no solutions.*
Academic Vocabulary:	solve, combine, recognize, compare, calculate, construct, define, interpret, increase, decrease, intersection, solution, positive, negative, input, output
Technical Vocabulary:	system of equations, system of functions, linear, non-linear, quadratic, classes of functions, constants, average rate of change, interval, explicit, recursive, function, arithmetic sequence, even function, odd function, Fibonacci sequence, relative maximum, relative minimum, symmetry, end behavior, periodicity, descriptive modeling, parameters