# Math I UNIT 4 OVERVIEW: Exponential Functions

## Unit Outcomes
At the end of this unit, your student should be able to:

- Classify exponential functions as growth or decay
- Compare/contrast properties and the graphs of linear and exponential functions
- Construct a graph of an exponential function from a table, sequence or a situation
- Model an exponential relationship between two quantities with tables, graphs, and equation
- Recognize that the solutions to an exponential equation are represented by the points on the graph
- Understand that a geometric sequence is a sequence of numbers where the ratio between consecutive numbers is constant
- Understand that an exponential function has a \( r \) value greater than 1 if the function is growing
- Identify the common ratio of the sequence
- Write the first and subsequent terms of the sequence
- Evaluate functions for given domains
- Recognize a pattern will allow them to determine an arithmetic or geometric model
- Translate between the recursive (NOW/NEXT) and explicit forms in modeling situations
- Construct a table and graph of a linear function with slope \( m \) and exponential rate of change equal to the slope to identify the point where the exponential function exceeds the linear function
- Determine the difference between the rate of change of a linear model (add each time) versus an exponential model (multiply each time)

## Key Vocabulary
Terms to deepen the student’s understanding:

- Base
- Common Ratio
- Constant
- Explicit Form
- Exponent
- Exponential Decay
- Exponential Equation
- Exponential Form
- Exponential Function
- Exponential Growth
- Function Notation
- Geometric Sequence
- Horizontal and Vertical Translation
- Initial Term
- Intercepts
- Intervals Where Increasing, Decreasing, Positive or Negative
- NOW-NEXT
- Rate of Change
- Relative Maximum
- Relative Minimum
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<table>
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<tr>
<th>Key Standards Addressed</th>
<th>Where This Unit Fits</th>
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<td><strong>Connections to Common Core/NC Essential Standards</strong></td>
<td><strong>Connections to prior and future learning</strong></td>
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<td>NC.M1.N-RN.2 Rewrite algebraic expressions with integer exponents using the properties of exponents.</td>
<td><strong>Coming into this unit, students should have a strong foundation in:</strong></td>
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| NC.M1.A-SSE.1a Interpret expressions that represent a quantity in terms of its context. | - Solving one variable equations  
- Graphing linear functions  
- Identifying the initial value for a linear function  
- Writing recursive and explicit forms of an equation  
- Identifying key features of a function from a graph  
- Simplify expressions using exponents  
- Investigating the laws of who number exponents. |
| a. Identify and interpret parts of a linear, exponential, or quadratic expression, including terms, factors, coefficients, and exponents. | **This unit builds to the following future skills and concepts:** |
| NC.M1.A-SSE.1b Interpret a linear, exponential, or quadratic expression made of multiple parts as a combination of entities to give meaning to an expression. | - Solving quadratic equations  
- Graphing and analyzing more complex functions (including inverse, step, exponential, absolute value, trigonometric and logarithmic functions)  
- Using regression models to predict linear, quadratic and exponential models |
| NC.M1.A-CED.2 Create and graph equations in two variables to represent linear, exponential, and quadratic relationships between quantities. | |
| NC.M1.A-REI.11 Build an understanding of why the x-coordinates of the points where the graphs of two linear, exponential, and/or quadratic equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$ and approximate solutions using graphing technology or successive approximations with a table of values. |  |
| NC.M1.F-IF.2 Use function notation to evaluate linear, quadratic, and exponential functions for inputs in their domains, and interpret statements that use function notation in terms of a context. |  |
| NC.M1.F-IF.3 Recognize that recursively and explicitly defined sequences are functions whose domain is a subset of the integers, the terms of an arithmetic sequence are a subset of the range of a linear function, and the terms of a geometric sequence are a subset of the range of an exponential function. |  |
| NC.M1.F-IF.4 Interpret key features of graphs, tables, and verbal descriptions in context to describe functions that arise in applications relating two quantities, including: intercepts; intervals where the function is increasing, decreasing, positive, or negative; and maximums and minimums. |  |
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NC.M1.F-IF.5 Interpret a function in terms of the context by relating its domain and range to its graph and, where applicable, to the quantitative relationship it describes.

NC.M1.F-IF.6 Calculate and interpret the average rate of change over a specified interval for a function presented numerically, graphically, and/or symbolically.

NC.M1.F-IF.7 Analyze linear, exponential, and quadratic functions by generating different representations, by hand in simple cases and using technology for more complicated cases, to show key features, including: domain and range; rate of change; intercepts; intervals where the function is increasing, decreasing, positive, or negative; maximums and minimums; and end behavior.

NC.M1.F-IF.8b Use equivalent expressions to reveal and explain different properties of a function. b). Interpret and explain growth and decay rates for an exponential function.

NC.M1.F-IF.9 Compare key features of two functions (linear, quadratic, or exponential) each with a different representation (symbolically, graphically, numerically in tables, or by verbal descriptions).

NC.M1.F-BF.1a Write a function that describes a relationship between two quantities. a. Build linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two ordered pairs (include reading these from a table).

NC.M1.F-BF.1b Build a function that models a relationship between two quantities by combining linear, exponential, or quadratic functions with addition and subtraction or two linear functions with multiplication.

NC.M1.F-BF.2 Translate between explicit and recursive forms of arithmetic and geometric sequences and use both to model situations.

NC.M1.F-LE.1 Identify situations that can be modeled with linear and exponential functions, and justify the most appropriate model for a situation based on the rate of change over equal intervals.

NC.M1.F-LE.3 Compare the end behavior of linear, exponential, and quadratic functions using graphs and tables to show that a quantity increasing exponentially eventually exceeds a quantity increasing linearly or quadratically.

NC.M1.F-LE.5 Interpret the parameters $a$ and $b$ in a linear function $f(x) = ax + b$ or an exponential function $g(x) = ab^x$ in terms of a context.

NC.M1.S-ID.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

- Fit a function to exponential data using technology. Use the fitted function to solve problems.
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## Additional Resources
- Teaching Videos made by Wake County teachers
- Exponential Growth and Decay
- Modeling exponential growth and decay (video)
- Graphing exponential functions (practice)
- Evaluating exponential functions (practice)
- Geometric sequences overview (video)
- Write explicit form of geometric sequences (practice)

## “Learning Checks”
- What considerations should be taken into account when determining the boundaries and scales of a graph?
- What are the key features of an exponential function?
- When given one of the four forms of information, what should be taken into consideration when determining the best function to model the situation?
- How do you determine the best model for a data pattern?
- Why is a multiplicative rate of change the key feature of an exponential function and how is it revealed in the different forms of this function (verbal, graph, table, equation)?
- When given a sequence, how do you identify whether it is arithmetic or geometric and how do you write a rule for the sequence?
- What does compound interest look like in the real world?
- How is the half-life of a radioactive element used to determine how much of a sample is left after a given period of time?
- How do exponential functions model real-world problems and their solutions?

*Please note*, the unit guides are a work in progress. If you have feedback or suggestions on improvement, please feel free to contact wakemiddle@wcpss.net.