Milford Public Schools Curriculum

Department: Mathematics
Course Name: Algebra 1 Level 2

UNIT 1

Unit Title: Intro to Functions and Exponential Expressions
Unit Description: Students explore the main functions that they will work with in Grade 9: linear, quadratic, and exponential. The goal is to introduce students to these functions by having them make graphs of situations (usually based upon time) in which the functions naturally arise. As they graph, they reason abstractly and quantitatively as they choose and interpret units to solve problems related to the graphs they create.
Students use the structure of expressions to define what it means for two algebraic expressions to be equivalent. In doing so, they discern that the commutative, associative, and distributive properties help link each of the expressions in the collection together, even if the expressions look very different themselves. They learn the definition of a polynomial expression and build fluency in identifying and generating polynomial expressions as well as adding, subtracting, and multiplying polynomial expressions.

LEARNING GOALS

Enduring Understanding(s):
- Inverse operations are an integral part of solving equations and inequalities.
- Functions and number operations play fundamental roles in helping us to make sense of various situations.

Essential Question(s):
- Why are relations and functions represented in multiple ways?
- How are the properties of functions and functional operations useful?
- How are inverse operations used in solving equations and inequalities?

Content and Skills:
Students will be able to:
- Apply the Distributive Property when evaluating functions.
- Evaluate Polynomials based on polynomial operations (adding, subtracting, multiplying)
- Determine the proper use of Solving Inequalities versus solving equations
- Analyze real life problem situations and use equations to model and solve
- Develop and use linear models for real life situations.
- Compare solutions of equations and inequalities.
- Isolate a variable given an equation with multiple variables. (Literal Equations)
- Understand that the sum or difference of two polynomials produces another polynomial and relate polynomials to the system of integers; students add and subtract polynomials.
- Understand that the product of two polynomials produces another polynomial; students multiply polynomials.

Standards Addressed:
NQ. A.1 Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; and choose and interpret the scale and the origin in graphs and data displays.
NQ. A.2 Define appropriate quantities for the purpose of descriptive modeling.
NQ. A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
AAPR. A.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.
AREI. A.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.
AREI. B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by

letters.
AREI. D.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).
ACED. 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
ACED. A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
ASSE. 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.

UNIT 2

Unit Title: Solving Equations/Inequalities and Creating Equations to Solve Problems
Unit Description: Instead of just solving equations, students formalize descriptions of what they learned before (variable, solution sets, etc.) and are able to explain, justify, and evaluate their reasoning as they strategize methods for solving linear and nonlinear equations. Students take their experience solving systems of linear equations further as they prove the validity of the addition method, learn a formal definition for the graph of an equation and use it to explain the reasoning of solving systems graphically, and represent the solution to systems of linear inequalities graphically. Students are formally introduced to the modeling cycle through problems that can be solved by creating equations and inequalities in one variable, systems of equations, and graphing.

LEARNING GOALS

Enduring Understanding(s):
- There are real world situations that can be modeled using two or more equations.
- There are a variety of factors to consider when solving systems of equations
- There are a variety of solutions to systems of equations ranging from no solution to infinite solutions.

Essential Question(s):
- What are the advantages and disadvantages of solving systems of linear equations graphically vs algebraically?
- What types of relationships can be modeled by systems of linear graphs?
- How can we use expressions, equations, and inequalities to model and solve real-world problems?

Content and Skills:
Students will be able to:
- understand the advantages and disadvantages of solving systems of linear equations graphically vs algebraically.
- create a system of equations/inequalities based on a real world problem
- understand which models to use in solving real world problems.
- understand the number of solutions to a system of equations or inequalities can vary from no solution to an infinite number of solutions.
- understand solutions to systems can be interpreted algebraically and in terms of problem context.
- understand there are situations that require two or more equations to be satisfied simultaneously.
- make predictions based on equations created and graphed on a coordinate plane.

Standards Addressed:
Standards and Practices
AREI. A.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.
AREI. B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
ACED. A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
ACED. A.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.
AREI. C.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.
AREI. C.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.
AREI. D.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).
AREI. D.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.
NQ. A.1 Use units as a way to understand problems and to guide the solution of multistep
problems; choose and
interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
ASSE. 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.
ACED. 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
ACED. A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
AREI. B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

UNIT 3

Unit Title: Linear and Exponential Functions;
Unit Description: In earlier grades, students defined, evaluated, and compared functions and used them to model relationships between quantities. In this module, students extend their study of functions to include function notation and the concepts of domain and range. They explore many examples of functions and their graphs, focusing on the contrast between linear and exponential functions. They interpret functions given graphically, numerically, symbolically, and verbally; translate between representations; and understand the limitations of various representations. Students explore arithmetic and geometric sequences as an introduction to the formal notation of functions. They interpret arithmetic sequences as linear functions and geometric sequences as exponential functions. Students connect their understanding of functions to their knowledge of graphing from Grade 8. They learn the formal definition of a function and how to recognize, evaluate, and interpret functions in abstract and contextual situations. Students examine the graphs of a variety of functions and learn to interpret those graphs to be able to describe key features as domain and range, intercepts, intervals where the function is increasing or decreasing, and intervals where the function is positive or negative. Students extend their understanding of piecewise functions and their graphs including the absolute value and step functions. Students use the absolute value function and other piecewise functions to investigate transformations of functions and draw formal conclusions about the effects of a transformation on the function's graph. Finally, students apply and reinforce the concepts of the module as they examine and compare exponential, piecewise, and step functions in a real-world context. They create equations and functions to model situations, rewrite exponential expressions to reveal and relate elements of an expression to the context of the problem, and examine the key features of graphs of functions, relating those features to the context of the problem.

LEARNING GOALS

Enduring Understanding(s):

- Some sequences can be modeled with a function rule that you can use to find any term of the sequence.
- Functions are used to model mathematical relationships between two quantities.
- The relationship between the variables in a function determines the function type.
- There are real world situations can be modeled both symbolically and graphically.
- The parent function is the simplest form of a function

Essential Question(s):

- What are the advantages and disadvantages of a recursive compared to an explicit rule?
- What is the difference between arithmetic and geometric sequences?
- What characterizes exponential growth and decay and how can we identify them in the real world?
- How do transformations, translations and reflections affect the parent function?
- What are the key features of a function and how do these features connect to real world applications?

Content and Skills:
Students will be able to:

● use exponent properties to solve exponential equations.
● interpret arithmetic sequences as linear functions and geometric sequences as exponential functions.
● analyze a real world application to decide whether a recursive or explicit rule would be more beneficial.
● analyze real world application problems to determine if they are exponential growth or decay.
● state the domain and range of each graph.
● analyze the effects a transformation and translation has on a parent function.
● apply the key features of a function to real world applications.

Standards Addressed:

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 REI. D.11 Explain why the coordinates of the points where the graphs of the equations and intersect are the solutions of the equation ; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where and/or are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.
A SSE. B.3c Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Use the properties of exponents to transform expressions for exponential functions.
FBF. A.1a Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from a context.
FBF. B.3 Identify the effect on the graph of replacing by by , , and for specific values of (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.*
FIF. A.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 is a function and is an element of its domain, then denotes the output of corresponding to the input . The graph of is the graph of the equation .
FIF. A.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
FIF. A.3 Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.
FIF. B.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.
FIF. B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
FIF. B.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.
FIF. C.7a Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Graph linear and quadratic functions and show intercepts, maxima,

and minima.
FIF. C.9 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal description).
FLE. A.1, Distinguish between situations that can be modeled with linear functions and with exponential functions. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal interval. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
FLE. A.2 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).
FLE. A.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
FLE. B.5 Interpret the parameters in a linear or exponential function in terms of a context.

UNIT 4

Unit Title: Polynomial and Quadratic Expressions, Equations, and Functions

Unit Description: Students learn the definition of a polynomial and how to add, subtract, and multiply polynomials. Here, their work with multiplication is extended and connected to factoring polynomial expressions and solving basic polynomial equations. They analyze, interpret, and use the structure of polynomial expressions to multiply and factor polynomial expressions. They understand factoring as the reverse process of multiplication. Students develop the factoring skills needed to solve quadratic equations and simple polynomial equations by using the zero product property. Students transform quadratic expressions from standard form, to factored form, and then solve equations involving those expressions. They identify the solutions of the equation as the zeros of the related function. Students apply symmetry to create and interpret graphs of quadratic functions. They use average rate of change on an interval to determine where the function is increasing or decreasing. Using area models, students explore strategies for factoring more complicated quadratic expressions, including the product sum method and rectangular arrays. They create one and two variable equations from tables, graphs, and contexts and use them to solve contextual problems represented by the quadratic function. Students then relate the domain and range for the function to its graph and the context.. The strategy known as *completing the square* is used to solve quadratic equations when the quadratic expression cannot be factored. Students recognize that this form reveals specific features of quadratic functions and their graphs, namely the *minimum* or *maximum of the function* (i.e., the vertex of the graph) and the line of symmetry of the graph. Students derive the quadratic formula by completing the square for a general quadratic equation in standard form, and use it to determine the nature and number of solutions for equations when equals zero. For quadratic equations with irrational roots, students use the quadratic formula and explore the properties of irrational numbers. With the added technique of completing the square in their toolboxes, students come to see the structure of the equations in their various forms as useful for gaining insight into the features of the graphs of equations. Students study business applications of quadratic functions as they create quadratic equations and graphs from tables and contexts and then use them to solve problems involving profit, loss, revenue, cost, etc. In addition to applications in business, students solve physics based problems involving objects in motion. In doing so, students also interpret expressions and parts of expressions in context and recognize when a single entity of an expression is dependent or independent of a given quantity. Students explore the families of functions that are related to the parent functions, specifically for quadratic, square root, and cube root, to perform horizontal and vertical translations as well as shrinking and stretching. They recognize the application of transformations in vertex form for a quadratic function and use it to expand their ability to efficiently sketch graphs of square and cube root functions. Students compare quadratic, square root, or cube root functions in context and represent each in different ways (verbally with a description, numerically in tables, algebraically, or graphically). In the final two lessons, students examine real-world problems of quadratic relationships presented as a data set, a graph, a written relationship, or an equation. They choose the most useful form for writing the function and apply the techniques learned throughout the module to analyze and solve a given problem, including calculating and interpreting the rate of change for the function over an interval.

LEARNING GOALS

Enduring Understanding(s):

- Algebraic models and graphical representations are tools that can help us make meaningful connections to solve real-world situations.
- Factors are a subset of a product and with the distributive property allow options in solving polynomials.
- Multiplying and factoring polynomials are related.
- Solving polynomials involves the reversal of operations, the distributive property and rules of exponents.
- There are a variety of strategies to consider when finding the roots of quadratic equations

Essential Question(s):

- How can you determine and use the relationships between models to further investigate future situations?
- How can we solve a quadratic equation and what do the solutions mean?
- How can the nature of the roots of a quadratic equation be determined from the graph of quadratic equation?
- What characteristics of a polynomial determine how to factor it completely?

Content and Skills:
Students will be able to:

- Factor Quadratic expressions and equations using various methods (when a=1, splitting the middle term, GCF)
- Multiply polynomials
- Factor quadratics using difference of two squares
- Factor quadratics using the method of perfect square binomials
- Apply the zero product property to find the roots of the quadratic equations.
- Simplify radicals
- Apply the quadratic formula, completing the square, factoring and graphing to the zero product property in order to solve for the roots of a quadratic equation.
- Use the discriminant of the quadratic formula in order to determine how many solutions it has.
- Create quadratic models of real life situations.

Standards Addressed:
NRN. B.3 Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

ASSE. 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.
ASSE. A.2 Use the structure of an expression to identify ways to rewrite it.
ASSE. B.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.
AAPR. A.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.
AAPR. B.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.
A-REI.B.4 Solve quadratic equations in one variable.
a. Use the method of completing the square to transform any quadratic equation in into an equation of the form that has the same solutions. Derive the quadratic formula from this form.
b. Solve quadratic equations by inspection (e.g., for), 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
F-IF.B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describe.
F-IF.C.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.
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.

UNIT 5

Unit Title: Descriptive Statistics

Unit Description: In this module, students reconnect with and deepen their understanding of statistics and probability concepts first introduced in Grades 6, 7, and 8. Students develop a set of tools for understanding and interpreting variability in data and begin to make more informed decisions from data. Students work with data distributions of various shapes, centers, and spreads. Measures of center and measures of spread are developed as ways of describing distributions. The choice of appropriate measures of center and spread is tied to distribution shape. The median and the interquartile range summarize data distributions that are skewed. Students calculate and interpret measures of center and spread and compare data distributions using numerical measures and visual representations. Students expand their understanding of linear relationships by connecting the data distribution to a model. Students explore positive and negative linear relationships and use the correlation coefficient to describe the strength and direction of linear relationships.

LEARNING GOALS

Enduring Understanding(s):

- The way that data is collected, organized and displayed influences interpretation.
- Data are collected for a purpose and have meaning in a context.
- Measures of central tendency describe how the data group.

Essential Question(s):

- How do we organize data so that it is useful in making decisions?
- How can you use data to predict an event?

Content and Skills:

Students will be able to:

- understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.
- use statistics appropriate to the shape of the data distribution to compare center and spread of two different data sets.
- interpret a scatterplot to predict values.

Standards Addressed:

SID. A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).
SID. A.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.
SID. A.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).
SID. B.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
SID. C.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
SID. C.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.
6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.
6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

UNIT 6

Unit Title: Synthesis and Modeling

Unit Description: Students synthesize what they have learned during the year about functions to select the correct function type in a series of modeling problems. Students no longer have the benefit of a module or lesson title that includes function type to guide them in their choices. Skills and knowledge from the previous modules will support the requirements of this module, including writing, rewriting, comparing, and graphing functions and interpretation of the parameters of an equation. Students must also draw on their study of statistics, using graphs and functions to model a context presented with data and/or tables of values. The modeling cycle is used as the organizing structure, rather than function type.

LEARNING GOALS

Enduring Understanding(s):

- Analyzing the data given helps one determine the model to represent the data set or sequence
- Creating a function to model real life situations is a useful tool to make predictions
- The level of precision needed is determined by the context of the problem.

Essential Question(s):

- What is the most appropriate way of modeling a mathematical situation in a particular situation?
- How do the graphs of mathematical models and data help us better understand the world in which we live?

Content and Skills:

Students will be able to:

- recognize linear, quadratic, and exponential functions when presented as a data set or sequence, and formulate a model based on the data.
- make sense of a contextual situation that can be modeled with linear, quadratic, and exponential functions when presented as a word problem.
- analyze a verbal description and create a model using equations, graphs, or tables.

Standards Addressed:

NQ. A.2 Define appropriate quantities for the purpose of descriptive modeling.
NQ. A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
ACED. A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales
FIF. B.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.
FIF. 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 ( ) gives the number of person hours it takes to assemble engines in a factory, then the positive integers would be an appropriate domain for the function.
FBF. A.1 Write a function that describes a relationship between two quantities. a. Determine an explicit expression, a recursive process, or steps for calculation from a context.
FLE. A.1 Distinguish between situations that can be modeled with linear functions and with exponential functions. b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
FLE. A.2 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).