Mathematics Course Syllabus

**Course Title:** Algebra 2 Level 3

**Department:** Mathematics

**Primary Course Materials:** Big Ideas Math Algebra 2 by Ron Larson and Laurie Boswell

**Course Description:**

(2015)

The depth and pace of the course is adjusted according to the individual needs, abilities and background of the students. This course is specifically designed for students who have successfully completed Algebra 1. This course can be taken simultaneously with Geometry. All students will be actively engaged in problem solving, reasoning, connecting and communicating mathematically as they study the following topics: linear functions, quadratic function, quadratic equations and complex numbers, polynomial functions, rational exponents and rational functions, and exponential and logarithmic functions. Students will be required to keep an organized notebook, read and interpret the algebra text and do independent work. Emphasis will be placed on investigating and solving real-world problems that will include open-ended and open-response questions. Since this course will advocate and encourage the proper use of technology, the purchase of a TI Nspire CX CAS graphing calculator is strongly recommended.

**Essential Questions:**

1. How are transformational properties of function families related to the algebraic representations of a function?
2. How are the function families used to analyze real world applications in a variety of disciplines (i.e. science, business, and economics)?
3. How can technology be used to deepen the understanding of function families and algebraic structures?

**Course Objectives:**

This course addresses the Chelmsford High School 21st Century Learning Expectations.

1. Demonstrate trans literacy by communicating across a range of platforms, tools, and media
2. Utilize real world digital tools and other resources to access, evaluate, and share information in an authentic task.
3. Demonstrate innovation, flexibility and adaptability in thinking patterns, work habits, and working/learning conditions.
4. Work independently and collaboratively to solve problems and accomplish goals.
5. Value and demonstrate personal responsibility, ethical behavior, and global awareness in both academic and social communities.

**Learning Standards from Common Core:**

A list is attached identifying which of the standards from the Massachusetts Common Core State Standards for Mathematics will be assessed in this course.

**Content Outline:**

**Chapter 1: Linear Functions** (15 Days)
- 1.1 Parent functions and Transformations
- 1.2 Transformations of Linear and Absolute Value Functions
- 1.3 Modeling with Linear Functions
- 1.4 Solving Linear Systems

**Chapter 2: Quadratic Functions** (17 Days)
- 2.1 Transformations of Quadratic Functions
- 2.2 Characteristics of Quadratic Functions
- 2.3 Focus of a Parabola
- 2.4 Modeling with Quadratic Functions

**Chapter 3: Quadratic Equations and Complex Numbers** (25 Days)
- 3.1 Solving Quadratic Equations
- 3.2 Complex Numbers
- 3.3 Completing the Square
- 3.4 Using the Quadratic Formula
- 3.5 Solving Non-Linear Systems
- 3.6 Quadratic Inequalities

**Chapter 4: Polynomial Functions** (31 Days)
- 4.1 Graphing Polynomial Functions
- 4.2 Adding, Subtracting, and Multiplying Polynomials
- 4.3 Dividing Polynomials
- 4.4 Factoring Polynomials
- 4.5 Solving Polynomial Functions
- 4.6 The Fundamental Theorem of Algebra
- 4.7 Transformations of Polynomial Functions
- 4.8 Analyzing Graphs of Polynomial Functions
- 4.9 Modeling with Polynomial Functions

**Chapter 5: Rational Exponents and Radical Functions** (22 Days)
- 5.1 nth Roots and Rational Exponents
- 5.2 Properties of Rational Exponents and Radicals
5.3 Graphing Radical Functions
5.4 Solving Radical Equations and Inequalities
5.5 Performing Function Operations
5.6 Inverse of a Function

Chapter 6: Exponential and Logarithmic Functions (9 Days)
6.1 Exponential Growth and Decay Functions
6.2 The Natural Base e
6.3 Logarithms and Logarithmic Functions

Common Core State Standards

Number and Quantity

CCSS.MATH.CONTENT.HSN.RN.A.1
Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.

CCSS.MATH.CONTENT.HSN.RN.A.2
Rewrite expressions involving radicals and rational exponents using the properties of exponents.

CCSS.MATH.CONTENT.HSN.Q.A.2
Define appropriate quantities for the purpose of descriptive modeling.

CCSS.MATH.CONTENT.HSN.CN.A.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.

CCSS.MATH.CONTENT.HSN.CN.A.2
Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

CCSS.MATH.CONTENT.HSN.CN.C.7
Solve quadratic equations with real coefficients that have complex solutions.

CCSS.MATH.CONTENT.HSN.CN.C.8
(+) Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$. 
CCSS.MATH.CONTENT.HSN.CN.C.9
(+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

**Algebra**

CCSS.MATH.CONTENT.HSA.SSE.A.1
Interpret expressions that represent a quantity in terms of its context.¹

* CCSS.MATH.CONTENT.HSA.SSE.A.1.A
  Interpret parts of an expression, such as terms, factors, and coefficients.

* CCSS.MATH.CONTENT.HSA.SSE.A.1.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.*

CCSS.MATH.CONTENT.HSA.SSE.A.2
Use the structure of an expression to identify ways to rewrite it. *For example, see x^4 - y^4 as (x^2)^2 - (y^2)^2, thus recognizing it as a difference of squares that can be factored as (x^2 - y^2)(x^2 + y^2).*

CCSS.MATH.CONTENT.HSA.SSE.B.3
Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.¹

* CCSS.MATH.CONTENT.HSA.SSE.B.3.C
  Use the properties of exponents to transform expressions for exponential functions. *For example the expression 1.15^t can be rewritten as (1.15^{1/12})^{12t} ≈ 1.012^{12t} to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.*

CCSS.MATH.CONTENT.HSA.APR.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.
CCSS.MATH.CONTENT.HS.A.APR.B.2
Know and apply the Remainder Theorem: For a polynomial \( p(x) \) and a number \( a \), the remainder on division by \( x - a \) is \( p(a) \), so \( p(a) = 0 \) if and only if \( (x - a) \) is a factor of \( p(x) \).

CCSS.MATH.CONTENT.HS.A.APR.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.

CCSS.MATH.CONTENT.HS.A.APR.C.4
Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity \( (x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2 \) can be used to generate Pythagorean triples.

CCSS.MATH.CONTENT.HS.A.APR.C.5
(+) Know and apply the Binomial Theorem for the expansion of \( (x + y)^n \) in powers of \( x \) and \( y \) for a positive integer \( n \), where \( x \) and \( y \) are any numbers, with coefficients determined for example by Pascal’s Triangle.¹

CCSS.MATH.CONTENT.HS.A.APR.D.6
Rewrite simple rational expressions in different forms; write \( \frac{a(x)}{b(x)} \) in the form \( q(x) + \frac{r(x)}{b(x)} \), where \( a(x) \), \( b(x) \), \( q(x) \), and \( r(x) \) are polynomials with the degree of \( r(x) \) less than the degree of \( b(x) \), using inspection, long division, or, for the more complicated examples, a computer algebra system.

CCSS.MATH.CONTENT.HS.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.

CCSS.MATH.CONTENT.HS.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.
CCSS.MATH.CONTENT.HS.A.CED.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. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

CCSS.MATH.CONTENT.HS.A.CED.A.4
Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law $V = IR$ to highlight resistance $R$.

CCSS.MATH.CONTENT.HS.A.REI.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.

CCSS.MATH.CONTENT.HS.A.REI.A.2
Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

CCSS.MATH.CONTENT.HS.A.REI.B.4
Solve quadratic equations in one variable.

  CCSS.MATH.CONTENT.HS.A.REI.B.4.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 $b$.

CCSS.MATH.CONTENT.HS.A.REI.C.6
Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.
CCSS.MATH.CONTENT.HS.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 $x^2 + y^2 = 3$.

CCSS.MATH.CONTENT.HS.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.

**Functions**

CCSS.MATH.CONTENT.HSF.IF.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.*

CCSS.MATH.CONTENT.HSF.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.*

CCSS.MATH.CONTENT.HSF.IF.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.

CCSS.MATH.CONTENT.HSF.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.
CCSS.MATH.CONTENT.HSF.IF.C.7.B
Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

CCSS.MATH.CONTENT.HSF.IF.C.7.C
Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

CCSS.MATH.CONTENT.HSF.IF.C.7.E
Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

CCSS.MATH.CONTENT.HSF.IF.C.8.B
Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y = (1.02)^t, y = (0.97)^t, y = (1.01)^{12t}, y = (1.2)^t/10, and classify them as representing exponential growth or decay.

CCSS.MATH.CONTENT.HSF.IF.C.9
Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

CCSS.MATH.CONTENT.HSF.BF.A.1
Write a function that describes a relationship between two quantities.

CCSS.MATH.CONTENT.HSF.BF.A.1.A
Determine an explicit expression, a recursive process, or steps for calculation from a context.

CCSS.MATH.CONTENT.HSF.BF.A.1.B
Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

CCSS.MATH.CONTENT.HSF.BF.B.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. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

**CCSS.MATH.CONTENT.HSF.BF.B.4**
Find inverse functions.

**CCSS.MATH.CONTENT.HSF.BF.B.4.A**
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. For example, \( f(x) = 2x^3 \) or \( f(x) = \frac{x+1}{x-1} \) for \( x \neq 1 \).

**CCSS.MATH.CONTENT.HSF.LE.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).

**CCSS.MATH.CONTENT.HSF.LE.A.4**
For exponential models, express as a logarithm the solution to \( ab^c = d \) where \( a, c, \) and \( d \) are numbers and the base \( b \) is 2, 10, or \( e \); evaluate the logarithm using technology.

**CCSS.MATH.CONTENT.HSF.LE.B.5**
Interpret the parameters in a linear or exponential function in terms of a context.

**CCSS.MATH.CONTENT.HSG.GPE.A.2**
Derive the equation of a parabola given a focus and directrix.

**CCSS.MATH.CONTENT.HSS.ID.B.6.A**
Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.