MATHEMATICS COURSE SYLLABUS

Course Title: *Algebra 2 Honors*

Department: Mathematics

Primary Course Materials: Big Ideas Math Algebra 2 Book Authors: Ron Larson & Laurie Boswell
TI-Nspire CX CAS

Course Description: This course is designed for ninth and tenth grade students who continue to demonstrate the necessary ability, maturity, and motivation to be successful in a rapidly paced algebra program. All students will be actively engaged in Problem Solving, Reasoning, Connecting, and Communicating as they study the following topics: Linear Functions, Quadratic Functions, Quadratic Equations and Complex Numbers, Polynomial Functions, Rational Exponents and Radical Functions, Exponential and Logarithmic Functions, Rational Functions, Sequences and Series, Trigonometric Ratios and Functions, Probability, and Data Analysis and Statistics.

Students will be required to keep a notebook, read and interpret the algebra text and complete independent work, including a major project each term. Emphasis will be placed on investigating and solving real world problems that will include open-ended and open response questions to assist in preparing students for the MCAS exam. Since the course will advocate and encourage the proper use of technology, the purchase of a TI Nspire CX CAS calculator is recommended.

Essential Questions:
1. Where and how are algebraic operations and concepts used to solve everyday problems?

2. How does algebra help us understand and relate to other objects as well as to other areas of mathematics?

3. How are the function families used to analyze real world applications in a variety of disciplines such as science, business, and economics?

4. How are function families used to model real world systems such as moving objects, revenue costs, population, and cost & profit?

5. How are transformational properties of function families related to the algebraic representations of a function?

6. How can technology be used to deepen understanding of function families and algebraic structures?

Course Objectives: This couse addresses the following common goals for Chelmsford High School:

Common Goals: 21st Century Learning Expectations

Thinking and Communicating
1) ☒ Read information critically to develop understanding of concepts, topics and issues.
2) ☒ Write clearly, factually, persuasively and creatively in Standard English.
3) ☒ Speak clearly, factually, persuasively and creatively in Standard English.
4) ☒ Use computers and other technologies to obtain, organize and communicate information and to solve problems.
5) ☒ Conduct research to interpret issues or solve complex problems using a variety of data and information sources.
6) ☒ Demonstrate transliteracy by communicating across a range of platforms, tools and media.
7) ☒ Utilize real-world digital tools and other resources to access, evaluate and share information in an authentic task.
8) ☒ Demonstrate innovation, flexibility and adaptability in thinking patterns, work habits and working/learning conditions.

Gain and Apply Knowledge in and across the Disciplines

9) Gain and Apply Knowledge in:
   a) ☐ Literature and Language
   b) ☒ Mathematics
   c) ☒ Science and Technology
   d) ☐ Social Studies, History and Geography
   e) ☐ Visual and Performing Arts
   f) ☐ Health and Physical Education

Work and Contribute
10) ☒ Demonstrate personal responsibility for planning one's future academic and career options.
11) ☐ Participate in a school or community service activity.
12) ☐ Develop informed opinions about current economic, environmental, political and social issues affecting Massachusetts, the United States and the world and understand how citizens can participate in the political and legal system to affect improvements in these areas.

13) ☒ Work independently and collaboratively to solve problems and accomplish goals.

14) ☒ Value and demonstrate personal responsibility, ethical behavior and global awareness in both academic and social communities.

Learning Standards from the Massachusetts Curriculum Framework:

A chart is attached identifying which of the standards from the Massachusetts Curriculum Frameworks will be assessed in this course.

PACING GUIDE

Chapter 1: Linear Functions (10 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 (10 DAYS)
- 2.1 Transformations of Quadratic Functions
- 2.2 Characteristics of Quadratic Functions
- 2.3 Focus of a Parabola
- 2.4 Modeling with Quadratic Equations

Chapter 3: Quadratic Equations and Complex Numbers (15 DAYS)
- 3.1 Solving Quadratic Equations
- 3.2 Complex Numbers
- 3.3 Completing the Square
- 3.4 Using the Quadratic Formula
- 3.5 Solving Nonlinear Systems
- 3.6 Quadratic Inequalities

Chapter 4: Writing Linear Functions (20 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 Equations
- 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 **(15 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 **(20 DAYS)**
- 6.1 Exponential Growth and Decay Functions
- 6.2 The Natural Base *e*
- 6.3 Logarithms and Logarithmic Functions
- 6.5 Properties of Logarithms
- 6.6 Solving Exponential and Logarithmic Equations
- 6.7 Modeling with Exponential and Logarithmic Functions

Chapter 7: Rational Functions **(15 DAYS)**
- 7.1 Inverse Variation
- 7.2 Graphing Rational Functions
- 7.3 Multiplying and Dividing Rational Expressions
- 7.4 Adding and Subtracting Rational Expressions
- 7.5 Solving Rational Equations

Chapter 10: Probability **(15 DAYS)**
- 10.1 Sample Spaces and Probability
- 10.2 Independent and Dependent Events
- 10.3 Two-Way Tables and Probability
- 10.4 Probability of Disjoint and Overlapping Events
- 10.5 Permutations and Combinations
- 10.6 Binomial Distributions

Chapter 9: Trigonometric Ratios and Functions **(15 DAYS)**
- 9.1 Right Triangle Trigonometry
- 9.2 Angles and Radian Measure
- 9.3 Trigonometric Functions of Any Angle
- 9.4 Graphing Sine and Cosine Functions

High School Content Standards

Content Standards

The Real Number System   N-RN

Extend the properties of exponents to rational exponents.

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.*
2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Use properties of rational and irrational numbers.

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.

Quantities   N-Q

Reason quantitatively and use units to solve problems.

1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. ★
2. Define appropriate quantities for the purpose of descriptive modeling. ★
3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. ★
   - MA.3.a. Describe the effects of approximate error in measurement and rounding on measurements and on computed values from measurements. Identify significant figures in recorded measures and computed values based on the context given and the precision of the tools used to measure. ★

The Complex Number System   N-CN

Perform arithmetic operations with complex numbers.

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.
2. Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.
3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

Represent complex numbers and their operations on the complex plane.

4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.
5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. *For example, $\left(-1+\sqrt{3i}\right)^3 = 8$ because $\left(-1+\sqrt{3i}\right)$ has modulus 2 and argument 120°.*
6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

Use complex numbers in polynomial identities and equations.

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* indicates Modeling standard.
(+) indicates standard beyond College and Career Ready.

7. Solve quadratic equations with real coefficients that have complex solutions.
8. (+) Extend polynomial identities to the complex numbers. *For example, rewrite $x^2 + 4$ as $(x + 2i)(x − 2i)$.*
9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

Vector and Matrix Quantities   N-VM

Represent and model with vector quantities.

1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, $|v|$, $\|v\|$, v).
2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.

Perform operations on vectors.

4. (+) Add and subtract vectors.
   a. (+) Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that (+) the magnitude of a sum of two vectors is typically not the sum of the magnitudes.
   b. (+) Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.
   c. (+) Understand vector subtraction $v − w$ as $v + (−w)$, where $−w$ is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.
5. (+) Multiply a vector by a scalar.
   a. (+) Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$.
   b. (+) Compute the magnitude of a scalar multiple cv using $\|cv\| = |c|v$. Compute the direction of cv knowing that when $|c|v ≠ 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$).

Perform operations on matrices and use matrices in applications.

6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.
7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.
8. (+) Add, subtract, and multiply matrices of appropriate dimensions.
9. (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.
10. (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.
11. (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.
12. (+) Work with 2×2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

Arithmetic with Polynomials and Rational Expressions   A-APR

Perform arithmetic operations on polynomials.

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.
   MA.1.a. Divide polynomials.

Understand the relationship between zeros and factors of polynomials.

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 $p(x)$.

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.

Use polynomial identities to solve problems.

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.*

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]

Rewrite rational expressions.

6. Rewrite simple rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, 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.

7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

Solve equations and inequalities in one variable.

4. Solve quadratic equations in one variable.
   a. Use the method of completing the square to transform any quadratic equation in *x* into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.
   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.

   MA.4.c. Demonstrate an understanding of the equivalence of factoring, completing the square, or using the quadratic formula to solve quadratic equations.

Interpreting Functions   F-IF

Interpret functions that arise in applications in terms of the context.

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.* ★

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.* ★

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. ★

Analyze functions using different representations.

7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. ★

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    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. *

    c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. *

    d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior. *

    e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. *

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.

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

    MA.8.c. Translate among different representations of functions and relations: graphs, equations, point sets, and tables.

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.*

MA.10. Given algebraic, numeric and/or graphical representations of functions, recognize the function as polynomial, rational, logarithmic, exponential, or trigonometric.

Building Functions	F-BF

5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Trigonometric Functions	F-TF

Extend the domain of trigonometric functions using the unit circle.

1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

2. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi - x$, $\pi + x$, and $2\pi - x$ in terms of their values for x, where x is any real number.

4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

Model periodic phenomena with trigonometric functions.

5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*

6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. *

Prove and apply trigonometric identities.

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8. Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant.
9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.