Groton Public Schools
Curriculum Map

INTRODUCTION
Course Title: **Honors Algebra II**
Curriculum Area and Grade: **Honors Algebra II (9th Grade & others**)

Course Purpose:
This course utilizes both a standards based and thematic approach to Algebra II at the honors level. Students will develop an in-depth knowledge of computational skills, real-world applications, and advanced functions for use in everyday life as well as future math courses. After completing this course, students will be thoroughly prepare for the SAT as it is aligned to the Common Core State Standards and also implements its area of study with the International Baccalaureate Middle Years Program framework in mind. Problem-solving is a key area of focus which will further develop knowledge and understand of algebra skills and concepts. Students will learn to work with expressions and solve equations and inequalities, understand nonlinear functions, study in detail quadratic functions, apply polynomial functions to the real world, and become familiar with exponential and rational functions.

Major Learning Goals and Understandings:
FHS Student Learning Expectation(s): SE1 Apply effective analysis, synthesis, and evaluative processes that enable productive problem solving. SE2 Communicate information clearly and effectively using a variety of tools/media in varied contexts and for a variety of purposes. SE3 Work independently and collaboratively to solve problems and accomplish goals. SE4 Use real-world digital and other research tools to access, evaluate and effectively apply information appropriate for authentic tasks. SE5 Demonstrate innovation, flexibility and adaptability in thinking patterns, work habits, and working/learning conditions. SE6 Value and demonstrate personal responsibility, character, cultural understanding, and ethical behavior. Course Specific Learning Expectations: 1.

Units/Theme/Concept and # of Weeks Quarter = 9 weeks, Semester=18 weeks, Trimester= 12 weeks, Year=36 weeks --- usually spread over 40 weeks	
1. **Expressions, Equations, and Inequalities (7-8 weeks)**	2. **Transformations of/Nonlinear Functions (5 weeks)**

3. **Quadratics (12 weeks)**	4. **Polynomial Functions (6-8 weeks)**
5. **Exponential and Rational Functions (8 weeks)**	

Mappers/Authors: L. Olson
Date Approved:

Part 1 – Unit 1: Expressions, Equations, Inequalities			
Grade: 9	**Subject:** Math	**Course:** Honors Algebra II	**Length of Unit:** 7-8 weeks

Common Core State Standards (Priority)

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 51/3 to be the cube root of 5 because we want (51/3)3 = 5(1/3)3 to hold, so (51/3)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.HSA.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.HSA.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.HSA.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.

Supporting Standards

CCSS.MATH.CONTENT.HSA.REI.B.3	Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
CCSS.MATH.CONTENT.HSA.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.HSA.REI.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.
CCSS.MATH.CONTENT.HSF.BF.A.1	Write a function that describes a relationship between two quantities.*

Part 2 – Standards	
Key (GLE) Content Knowledge and Concepts/Skills	**Bloom's Taxonomy Levels** Creating, Evaluating, Analyzing, Applying, Understanding and Remembering

The students will know:	The students will be able to:	During this unit of study, all levels will be used for multiple learning experiences.
1. Finding a solution to an equation always involves the process of undoing operations. 2. Finding a solution to an absolute value equation involves solving for both possible solutions and checking for extraneous solutions. 3. Equations may have one solution, no solution, or infinite solutions. 4. Inequalities have a solution set that can be represented with a graph. 5. Equations and inequalities can be used to model real-world situations. 6. Strategies for solving multi-step equations. 7. Laws of Exponents. 8. There are multiple forms of a linear equation. 9. How to solve a system of linear equations graphically and algebraically. 10. Writing the equation of a linear function can be done with a variety of information about the function.	1. Solve multi-step equations, absolute value equations, and radical equations in one variable. 2. Solve and graph the solution to multi-step inequalities, absolute value inequalities, compound inequalities all in one variable. 3. Simplify radical expressions. 4. Understand rational exponents and simplify expressions containing rational exponents. 5. Graph linear functions and write the equation of a line given its graph. 6. Calculate the slope of a line given its graph or two points on the line. 7. Determine the equation for a linear function when given two points or the slope and a point. 8. Graph linear equations and inequalities written in slope-intercept form, standard form, and point-slope form. 9. Solve systems of equations using the graphing method, the substitution method, and the elimination method. 10. Model and solve real-world situations using linear optimization.	

Big Idea and Essential Questions***

- **Big Ideas**
  1. The solution to an equation is the value that satisfies the equation (makes it true).
  2. An equation in one variable can have one solution, no solution, or infinite solutions.
  3. Inverse operations are used to solve for a variable.
  4. The solution to an inequality is the set of values that make the inequality true.
  5. There are multiple forms of linear functions based on the information known about the function.

6. The solution to a system of equations is the ordered pair that makes both equations true.

- **Essential Questions**
  1. What are the characteristics of an equation?
  2. What does equality mean?
  3. How do we determine if a relationship is equivalent?
  4. To what extent can equations be used to model all relationships?
  5. How can we use linear equations and linear inequalities to solve real world problems?

Part 3 – Common Unit Assessments

1. Cab Fares Performance Assessment
2. Mid Unit Test
3. Farmers Subsidies Task

Part 4 – Common/Assured Learning Experiences

- Students will practice solving a variety of one-variable equations, including multi-step equations, radical equations, and absolute value equations.
- Students will practice modeling a variety of real-world situations by solving word problems.

Part 5 – Teacher Notes

- Students should practice basic algebra skills to ensure endurance when solving more complicated equations.
- Students should practice making decisions and assumptions while solving word problems for the Cab Fares Performance Task to prepare for the Farmers Subsidies Task.

Part 1 – Unit 2: Transformations of/Nonlinear Functions			
Grade: 9	**Subject:** Math	**Course:** Honors Algebra II	**Length of Unit:** 5 Weeks

Common Core State Standards	
CCSS.MATH.CONTENT.HSA.REI.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).
CCSS.MATH.CONTENT.HSF.IF.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 f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of *f* is the graph of the equation y = f(x).
CCSS.MATH.CONTENT.HSF.IF.A.2	Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
CCSS.MATH.CONTENT.HSF.IF.B.4	Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
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.

Supporting Standards	
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.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.
CCSS.MATH.CONTENT.HSF.IF.C.7.B	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.
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.

<table>
<tr><th colspan="3">Part 2 – Standards</th></tr>
<tr><th colspan="2">Key (GLE) Content Knowledge and Concepts/Skills</th><th>Bloom's Taxonomy Levels
Creating, Evaluating, Analyzing, Applying, Understanding and Remembering</th></tr>
<tr><td>The students will know:
1. A function is a relation in which each input has exactly one output.
2. What it means for a function to be one-to-one, onto, or both.
3. Graphs, tables, and equations for the 8 main parent functions and their transformations.</td><td>The students will be able to:
1. Represent relations and functions using ordered pairs, tables, mapping diagrams, and graphs.
2. Identify the domain and range of a given relation or function.
3. Apply transformations (vertical and horizontal shift, scalar multiple) to parent functions</td><td>During this unit of study, all levels will be used for multiple learning experiences.</td></tr>
</table>

4. A line of best fit can be used to make predictions for a scatter plot if there is a correlation between two variables. 5. Piecewise functions can be used to model data in which more than one function would be appropriate, based on the domain.	(linear, quadratic, cubic, absolute value, and square root) using graphs, tables, and equations. 4. Interpret scatter plots and find the line of best fit using the calculator and by hand. 5. Identify and interpret piecewise functions.	

Big Idea and Essential Questions

- **Big Ideas**
  1. A function is a type of relation in which each input has exactly one output.
  2. A function can be defined as one to one, onto, or both.
  3. Functions can be comprised of a series of transformations applied to a parent function.
  4. Interpreting the line of best fit by hand or with a calculator enables generalizations about the trend of the data to be made.

Essential Questions

1. What are the characteristic of the different families of functions?
2. How can generalizations about functions enable you to accurately model real-world situations?
3. To what extent might form enable you to represent patterns?
4. Do scale, duration, frequency, and variability enable us to identify and understand a pattern?

Part 3 – Common Unit Assessments

1. Unit 2 Test

Part 4 – Common/Assured Learning Experiences

1. Students will create their own examples and non-examples of functions and explain how they know if a relation is a function.
2. Students will identify parent functions by analyzing their graphs, tables, and equations.
3. Students will create their own scatter plots and determine the line of best fit by hand and on their calculator.

Part 5 – Teacher Notes
• Students should practice graphing and writing equations for parent functions and their transformations extensively prior to the Unit 2 Test. • Students should practice creating and interpreting scatter plots both by hand and using the calculator prior to the Unit 2 Test.

Part 1 – Unit 3: Quadratic Functions			
Grade: 9	**Subject:** Math	**Course:** Honors Algebra II	**Length of Unit:** 12 Weeks

Common Core State Standards

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 i2 = -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 i2 = -1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.
CCSS.MATH.CONTENT.HSN.CN.A.3	(+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.
CCSS.MATH.CONTENT.HSN.CN.C.7	Solve quadratic equations with real coefficients that have complex solutions.
CCSS.MATH.CONTENT.HSA.SSE.A.2	Use the structure of an expression to identify ways to rewrite it. For example, see x4 - y4 as (x2)2 - (y2)2, thus recognizing it as a difference of squares that can be factored as (x2 - y2)(x2 + y2).
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.*
CCSS.MATH.CONTENT.HSA.SSE.B.3.A	Factor a quadratic expression to reveal the zeros of the function it defines.
CCSS.MATH.CONTENT.HSA.REI.B.4	Solve quadratic equations in one variable.

Supporting Standards

CCSS.MATH.CONTENT.HSA.REI.B.4.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.

CCSS.MATH.CONTENT.HSA.REI.B.4.B	Solve quadratic equations by inspection (e.g., for x2 = 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 ± bi for real numbers a and b.
CCSS.MATH.CONTENT.HSA.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 x2 + y2 = 3.
CCSS.MATH.CONTENT.HSF.IF.C.7.A	Graph linear and quadratic functions and show intercepts, maxima, and minima.
CCSS.MATH.CONTENT.HSF.IF.C.8	Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

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<tr>
<td>The students will know:
1. A quadratic function is a function in which there is a constant second difference.
2. Quadratic functions can be written in standard form or vertex form information provided.
3. The graph of a quadratic function forms a u-shape called a parabola.
4. Nonreal solutions of a quadratic function are called complex roots.
5. Identifying the most efficient method to solve a quadratic function depends on the function given.
6. Quadratic function inequalities and quadratic-linear systems have a solution set that can be shown graphically and algebraically.
7. Quadratic functions can be used to model real-world situations.</td>
<td>The students will be able to:
1. Identify quadratic functions using graphs, tables, and equations
2. Solve quadratic functions by graphing, factoring, completing the square, and using the quadratic formula.
3. Solve real world applications using quadratic functions.
4. Understand complex numbers and simplify expressions with complex numbers.
5. Solve quadratic functions using the quadratic formula with complex roots.
6. Transform quadratic functions from standard form to vertex form.
7. Solve quadratic inequalities graphically and algebraically.
8. Solve quadratic-linear systems graphically and algebraically.</td>
<td>During this unit of study, all levels will be used for multiple learning experiences.</td>
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Big Idea and Essential Questions

- **Big Ideas**
  1. A quadratic function is a function that has a constant second difference ; a quadratic function forms a u-shape called a parabola.
  2. Quadratic functions can be written in multiple forms and solved using multiple methods.
  3. Quadratic functions can have two real solutions, one real solution, or two complex solutions.
  4. Quadratic functions can be used to model real-world situations.

- **Essential Questions**
  1. What are the characteristics of a quadratic function?
  2. What are the minimum requirements needed in order to model a parabolic object with an algebraic equation?
  3. How can you represent a quadratic relationship?
  4. Which representation of a quadratic do you find most useful?
  5. Are real life problems more easily solved when a model is available?

Part 3 – Common Unit Assessments

1. Angry Birds Performance Task
2. Cirque du Soleil Performance Task
3. Unit 3 Test

Part 4 – Common/Assured Learning Experiences

1. Students will practice graphing quadratic functions in both forms.
2. Students will practice solving quadratic functions using all methods.
3. Students will practice transforming quadratic functions between forms.
4. Students will practice modeling real-world situations by solving word problems.
5. Students will become familiarized with complex numbers.

Part 5 – Teacher Notes

• Students should practice graphing quadratic functions and identifying relevant information from a word problem for the Cirque du Soleil Performance Task and Angry Birds Performance Task.

Part 1 – Unit 4: Polynomial Functions			
Grade: 9	**Subject:** Math	**Course:** Honors Algebra II	**Length of Unit:** 6-8 Weeks

Common Core State Standards

	Represent
CCSS.MATH.CONTENT.HSA.SSE.A.1.A	Interpret parts of an expression, such as terms, factors, and coefficients.
CCSS.MATH.CONTENT.HSA.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.HSA.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.HSA.APR.D.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.
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.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.C	Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

Part 2 – Standards		
Key (GLE) Content Knowledge and Concepts/Skills		**Bloom's Taxonomy Levels** Creating, Evaluating, Analyzing, Applying, Understanding and Remembering
The students will know:	The students will be able to: 1. Add, subtract, and multiply polynomials.	During this unit of study, all levels will be used for multiple learning experiences.

1. Polynomial functions can be added, subtracted, multiplied, and divided. 2. Long division and synthetic division can be used to divide polynomials. 3. Graphs, tables, and equations of polynomial functions each provide important characteristics of polynomial functions, such as roots, turning points, and end behavior. 4. Solving a polynomial function completely means identifying all of the roots (x-intercepts) of the function.	2. Divide polynomials using long division and synthetic division. 3. Analyze the graphs and tables of polynomial functions. 4. Factor polynomial functions and solve a polynomial function by factoring. 5. Apply the Remainder and Factor Theorem to determine if a value is a root. 6. Determine the number of roots a polynomial function has using Descartes Rule of Signs. 7. Use the Rational Root Theorem to identify possible roots of a polynomial function and solve polynomial functions completely.	

Big Idea and Essential Questions

- **Big Ideas**
  1. Much like solving a quadratic function, solving a polynomial function means finding the roots of the function, either graphically or algebraically.
  2. The degree and leading coefficient of a polynomial function is useful in identifying the shape and direction of the graph.
  3. Mathematicians are able to use multiple theorems together to solve complex problems.
  4. Polynomial functions can represent real world situations.

- **Essential Questions**
  1. What are the characteristics of a polynomial function?
  2. Why is it important to study polynomial functions?

3. Can the nature of roots be helpful in solving higher degree polynomial functions?

Part 3 – Common Unit Assessments

1. Roller Coaster Project

Part 4 – Common/Assured Learning Experiences

1. Students will add, subtract, multiple, and divide polynomials
2. Students will factor and solve polynomials
3. Students will learn and understand theorems about polynomials

Part 5 – Teacher Notes

- Confidence and mastery in skills from previous units are essential for success with polynomials
- Students should practice creating polynomials when given specific restraints before completing the Roller Coaster Project

Part 1 – Unit 5: Exponential and Rational Functions			
Grade: 9	**Subject:** Math	**Course:** Honors Algebra II	**Length of Unit:** 8 Weeks

Common Core State Standards

CCSS.MATH.CONTENT.HSA.REI.A.2	Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.
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.D	(+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
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 $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)12^t$, $y = (1.2)^t/10$, and classify them as representing exponential growth or decay.
CCSS.MATH.CONTENT.HSF.BF.B.4	Find inverse functions.

Supporting Standards

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) =2 x3 or f(x) = (x+1)/(x-1) for x ≠ 1.
CCSS.MATH.CONTENT.HSF.BF.B.4.B	(+) Verify by composition that one function is the inverse of another.
CCSS.MATH.CONTENT.HSF.LE.B.5	Interpret the parameters in a linear or exponential function in terms of a context.

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<tr><td>The students will know:
1. Inverse functions are functions in which $f(a) = b$ and $f^{-1}(b) = a$; inverse functions can be found graphically and algebraically.
2. Square root functions have a restricted domain.
3. Exponential functions have a growth/decay factor that will cause them to increase or decrease rapidly.
4. Exponential functions have a horizontal asymptote.
5. Rational expressions can be simplified by identifying common</td><td>The students will be able to:
1. Perform operations with functions.
2. Determine whether or not two functions are inverses and find the inverse of a function.
3. Graph square root functions.
4. Graph exponential functions.
5. Solve exponential functions without the use of logarithms.
6. Add, subtract, multiply and divide rational expressions.
7. Solve rational equations.
8. Graph rational functions using a table and by identifying asymptotes.
9. Apply rational functions to real world situations.</td><td>During this unit of study, all levels will be used for multiple learning experiences.</td></tr>
</table>

factors or a least common denominator. 6. Rational functions may have asymptotes and/or points of discontinuity.		

Big Idea and Essential Questions

- **Big Ideas**
  1. Inverse functions can be identified algebraically and graphically.
  2. Transformation rules can be applied to graph square root and exponential functions.
  3. Exponential functions can be used to model real word situations, such as half-life and compound interest.
  4. Identifying asymptotes and points of discontinuity are crucial when graphing rational functions.

- **Essential Questions**
  1. What does it mean to be an inverse?
  2. What strategies can be used to solve rational and square root functions?
  3. To what extent should mathematics influence consumer decisions?

Part 3 – Common Unit Assessments

1. M&M Exponential Functions Lab
2. Appliances Performance Task
3. Unit 5 Test

Part 4 – Common/Assured Learning Experiences

1. Students will practice graphing square root, exponential, and rational functions.
2. Students will practice solving exponential functions and rational equations.
3. Students will solve real-world problems and interpret their solutions.

Part 5 – Teacher Notes

- Students should practice researching and organizing information for the Appliances Performance Task