Salem County Vocational and Technical School District

Algebra II Curriculum

BOE Approved: August 2024

District Mission Statement/Standards and Commitments

Mission Statement

The mission of the Salem County Vocational Technical School District is to prepare students for employment, for further education leading to employment, and for lifelong learning.

Standards and Commitments

Our schools will provide an engaging and challenging curriculum that addresses the New Jersey Student Learning Standards (NJSLS). Teaching and learning will take place in physically and emotionally safe environments that have an active commitment to ensure trust, mutual respect, communication, effective collaboration, and good citizenship. The vision of Salem County Vocational and Technical School District is that all students develop the skills, knowledge, and attitudes necessary to succeed in life.

Course Description

The Algebra II curriculum is comprised of the following major concepts: (1) expressions, equations, and inequalities; (2) polynomial functions and graphs; (3) rational, irrational, and complex numbers; (4) quadratic equations and inequalities; (5) rational functions and graphs; (6) exponential and logarithmic functions; (7) sequences and series; (8) statistics and probability; and (9) matrices. While knowledge of content is being developed, students are engaged in hands-on and cooperative activities that encourage mathematical reasoning, problem solving, communicating, and making connections. Through these activities students utilize technology such as graphing calculators, computers, and calculator-based lab equipment. In addition, they are encouraged to think more critically through activities that will involve investigations, explorations, and discovery. Finally, evaluations appear in several formats: pencil and paper tests, performance tasks, and long- and short-term projects.

Unit 1 Pacing Guide- 20 days

Chapter		
Chapter 1	6 days	Linear Functions
Chapter 2	6 days	Quadratic Functions
Chapter 3	8 days	Quadratic Equations and Complex Numbers

Unit 2 Pacing Guide- 20 days

Chapter		
Chapter 4	10 days	Polynomial Functions
Chapter 5	8 days	Rational Exponents and radical Functions

Unit 3 Pacing Guide- 25 days

Chapter		
Chapter 6	9 days	Exponential and Logarithmic Functions
Chapter 7	8 days	Rational Functions
Chapter 8	8 days	Data Analysis and Statistics

Unit 4 Pacing Guide- 25 days

Chapter		
Chapter 9	10 days	Trigonometric Rations and Functions
Chapter 10	7 days	Sequence and Series
Chapter 11	8 days	Matrices

STANDARDS FOR MATHEMATICAL PRACTICE

SMP.1: Make sense of problems and persevere in solving them.
SMP.2: Reason abstractly and quantitatively.
SMP.3: Construct viable arguments and critique the reasoning of others.
SMP.4: Model with mathematics.
SMP.5: Use appropriate tools strategically.
SMP.6: Attend to precision.
SMP.7: Look for and make use of structure.
SMP.8: Look for and express regularity in repeated reasoning.

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Unit 1- Linear and Quadratic Functions

Course: Algebra II	**Timeframe**: 20 Days

Unit Focus/ Big Ideas

- Linear functions are all transformations of the function f(x)=x. You can use linear functions to model quantities that grow by equal amounts over equal intervals.
- A quadratic function can be written in the form $f(x)= ax^2 + bx + c$, where a, b, and c are real numbers.
- Quadratic equations with no real solutions have two imaginary solutions, meaning the solutions are complex numbers.

Unit 1 Pacing Guide- 20 days

Chapter		
Chapter 1	6 days	**Linear Functions** 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	6 days	**Quadratic Functions** 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	8 days	**Quadratic Equations and Complex Numbers** 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 of Equations 3.6 Quadratic Inequalities

Unit 1 Essential Questions	Unit 1 Enduring Understandings
● What are the advantages of a quadratic function in vertex form? ● What are the advantages of a quadratic function in standard form? ● How is any quadratic function related to the parent quadratic function y=x2? ● How are the real solutions of a quadratic equation related to the graph of the related quadratic function?	● The graph of any quadratic function is a transformation of the graph of the parent quadratic function, y=x2. ● For any quadratic function $f(x)=ax^2+bx+c$, the values of a, b, and c provide key information about its graph. ● Three noncollinear points, no two of which are in a line vertically, are on the graph of exactly one quadratic function. ● You can solve systems involving quadratic equations using methods similar to the ones used to solve systems of linear equations.

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	● To find the zeros of a quadratic function $y=ax^2+bx+c$, solve the related quadratic equation $0=ax^2+bx+c$. ● You can factor many quadratic trinomials into products of two binomials. ● Completing a perfect square trinomial allows you to factor the completed trinomial as the square of a binomial. ● You can solve a quadratic equation in more than one way. In general, you can find a formula that gives values of x in terms of a, b, and c. ● A basis for the complex numbers is a number whose square is -1. Every quadratic equation has complex number solutions (that sometimes are real numbers).

Unit 1 NJSLS Standards

Chapter	Standards	
Chapter 1	● A.CED.A.2 ● A.CED.A.3 ● F.BF.B.3 ● F.IF.B.5 ● F.IF.C.7.b ● F.IF.C.9	● Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. ● 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. ● 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. ● Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. ● Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. ● Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
Chapter 2	● A.CED.A.2 ● A.SSE.A.1.a ● F.BF.B.3 ● F.IF.B.4 ● F.IF.C.7.c ● F.IF.C.9	● Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. ● Interpret parts of an expression, such as terms, factors, and coefficients. ● 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. ● 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. ● Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

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		• Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
Chapter 3	• N.CN.A.1 • N.CN.A.2 • N.CN.C.7 • A.CED.A.1 • A.CED.A.3 • A.REI.D.11 • A.SSE.A.1.b	• 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. • Use the relation i 2 = –1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers • Solve quadratic equations with real coefficients that have complex solutions. • 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. • 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. • 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. • Interpret complicated expressions by viewing one or more of their parts as a single entity.

Unit 1 Instructional Plan

Unit 1 Pre-Assessment
Common Pre-assessment given prior to this unit to build a base of student understanding.

Unit 1 Evidence of Learning-Assessments	
Formative	Daily Warm-up, Daily Closure Activity, Daily Teacher Observations, Class Participation, Homework, Gimkits, Kahoots, Quizizz, Paper Based Quiz, Academic Games, and Group Work.
Summative	Chapter Tests, Standards Mastery Assessments
Benchmark	Link It Benchmark
Alternative Assessments	Project Students can research how a time-saving linear programming method, developed by Narendra Karmarkar, is used in companies today. <>

Unit 1 Instructional and Supplemental Materials	
Instructional Materials	Concepts and Connections Chapters 1-3, Delta Math, CalcChat, Gimkit, Kahoot, Quizizz, Desmos, Edulastic, and Geogebra
Equipment	Ruler/Straight Edge, Calculator, and Computer with Internet Access.

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Unit 1 Instructional and Supplemental Materials	
Supplemental Unit Resources	A.REI.B.4 Completing the Square A.REI.D.11 Two Squares are Equal A.SSE.A.2 Equivalent Expressions F.IF.9 Throwing Baseballs Person Puzzle - Irena Sendler ^
Intervention Resources	Tier II-III Interventions: Concepts and Connections

Unit 1 Instructional Best Practices	
• Establish mathematic goals to focus learning • Direct Instruction • Mini Lessons • Identifying Similarities and Differences • Summarizing and Note Taking • Reinforcing Effort and Providing Recognition • Homework and Practice • Modeling • Cooperative Learning • Setting Objectives and providing Feedback • Cues, Questions, and Advance Organizers • Homework and Practice • Technology Infusion • Cooperative Learning • Checks for Understanding (Check for Understanding Strategies Description) • Closure	• Gradual Release of Responsibility • Managing response rates • Checks for understanding • Diagrams, charts and graphs • Coaching • Use and connect mathematical representations. • Visuals • Collaborative problem solving • Active engagement strategies • Establishing metacognitive reflection and articulation • Implement tasks that promote reasoning and problem solving.

Unit 1 Related Misconception(s) /Clarifications
• When identifying the vertex of a quadratic in vertex form students will often forget to change the sign of the h-value. • Error prevention; explain that s stretch moves each y-value higher as if the parabola were stretched up, but it is not described as being thinner. • A positive horizontal translation will move the graph left and not right. • Students may mistakenly try to “distribute” an exponent to a binomial. • Students may mix up the equations for a vertical and horizontal line. • Students should review function notation, as they may not be comfortable or familiar with it. • Students may get inaccurate answers in the calculator due to misuse or lack of parenthesis. • When factoring, students may mix up b and ac in the quadratic function. • When factoring, students may forget to check for a gcf to factor out.

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Unit 1 Related Misconception(s) /Clarifications
• When factoring, students may not completely factor a problem. • Students may confuse methods for factoring special cases (perfect square trinomials and difference of squares). • Students may misidentify perfect square trinomials by only looking for perfect squares in the first and last terms. • Students may not use the zero-product property correctly by forgetting to change the signs of the factors. • Students may not use the zero-product property correctly by trying to apply it to equations not equal to zero. • When completing the square, students may only add (b/2)^2 to one side of the equation. • When completing the square, students may only take the square root of one side of the equation. • When completing the square, students may forget to include a + or - when taking the square root. • When solving by quadratic formula, students may switch values for a and b when plugging them in. • When solving by quadratic formula, students may forget to include the - in the front of the formula. • When solving by quadratic formula, students may forget to switch signs when plugging a negative number into a negative variable. • When solving by quadratic formula, students may forget to make sure that the function is in standard form first. • When "foiling" complex numbers, students may forget to include the i^2 on the last term. • When solving quadratic systems of inequalities, students may mix up the shading for the graphs.

Unit 1 Interdisciplinary Connections
SL.PE.11-12.1.A Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. SL.PE.11-12.1.B Collaborate with peers to promote civil, democratic discussions, and decision-making, set clear goals and assessments, and establish individual roles as needed. 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving

Unit 1 Integration of Technology
8.2.12.ED.2: Create scaled engineering drawings for a new product or system and make modifications to increase optimization based on feedback.

Unit 1 Academic Vocabulary	
axis of symmetry	minimum value
complex number,	maximum value
discriminant	factoring
greatest common factor	perfect square trinomial
imaginary number	difference of two squares
parabola	zero product property

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Unit 1 Academic Vocabulary	
quadratic formula quadratic function standard form vertex form zero of a function vertex of a parabola	completing the square imaginary unit pure imaginary number complex number plane absolute value of a complex number complex conjugates

Unit 2- Polynomial Functions, Rational Exponents, and Radical Functions

Course: Algebra II	**Timeframe**: 20 Days

Unit Focus/ Big Ideas

- A polynomial function is a monomial or sum of monomials.
- A radical function has a radical expression with the independent variable in the radicand.

Unit 2 Pacing Guide- 20 days

Chapter		
Chapter 4	10 days	**Polynomial Functions** 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	8 days	**Rational Exponents and Radical Functions** 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 Composition of Functions 5.7 Inverse of a Function

Unit 2 Essential Questions	Unit 2 Enduring Understandings
• What does the degree of a polynomial tell you about its related polynomial function? • For a polynomial function, how are factors, zeros, and x-intercepts related? • For a polynomial equation, how are factors and roots related? • To simplify the nth root of an expression, what must be true about the expression? • When you square each side of an equation, is the resulting equation equivalent to the original? • How are a function and its inverse function related?	• A polynomial function has distinguishing "behaviors." You can look at its algebraic form and know something about its graph. You can look at its graph and know something about its algebraic form. • Knowing the zeros of a polynomial function can help you understand the behavior of its graph. • If (x - a) is a factor of a polynomial, then the polynomial has value 0 when x = a. If a is a real number, then the graph of the polynomial has (a, 0) as an x-intercept. • The graph of the function y = af(x - h) + k is a vertical stretch or compression by a factor a , a horizontal shift of h units, and a vertical shift of k units of the graph of y = f(x). • You can divide polynomials using steps that are similar to the long division steps that you use to divide whole numbers. • The factors of the numbers an and a0 in P(x) = anxn+ an-1xn-1+ … can help you factor P(x) and solve the equation P(x) = 0. • The degree of a polynomial equation tells you how many roots the equation has. • You can use a pattern of coefficients to write the expansion of (a + b)n. •
	• Corresponding to every power, there is a root. • If the nth root of a and the nth root of b are real numbers, then the nth root of a times the nth root of b equals the nth root of a times b. • You can combine like radicals using properties of real numbers. • You can write a radical expression in an equivalent form using a fractional (rational) exponent instead of a radical sign. • Solving a square root equation may require that you square each side of the equation. This can introduce extraneous solutions. • You can add, subtract, multiply, and divide functions based on how you perform these operations for real numbers. One difference, however, is that you must consider the domain of each function. • The inverse of a function may or may not be a function. • A square root function is the inverse of a quadratic function that has a restricted domain.

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Unit 2 NJSLS Standards		
Chapter	**Standards**	
Chapter 4	• N.CN.C.8 • N.CN.C.9 • A.APR.A.1 • A.APR.B.2 • A.APR.B.3 • A.APR.C.4+ • A.APR.C.5 • A.APR.D.6 • A.CED.A.2 • A.SSE.A.1.b • A.SSE.A.2 • F.BF.B.3 • F.IF.B.4 • F.IF.B.6 • F.IF.C.7	• Extend polynomial identities to the complex numbers. For example, rewrite x2 + 4 as (x + 2i)(x – 2i). • Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials. • 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. • 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). • 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 • (+) Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x2 + y2) 2 = (x2 – y2) 2 + (2xy) 2 can be used to generate Pythagorean triples. • 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. • 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. • Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales • 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. • 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). • 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. • 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. • Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. • Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
Chapter 5	• A.CED.A.4 • A.REI.A.2 • F.BF.A.1.b • F.BF.A.1.c • F.BF.B.3 • F.BF.B.4.a	• Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. • Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise • Combine standard function types using arithmetic operations. • Compose functions.

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	• F.IF.C.7.b	• 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. • 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. • Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

Unit 2 Instructional Plan

Pre-Assessment
Common Pre-assessment given prior to this unit to build a base of student understanding.

Unit 2 Evidence of Learning-Assessments	
Formative	Daily Warm-up, Daily Closure Activity, Daily Teacher Observations, Class Participation, Homework, Gimkits, Kahoots, Quizizz, Paper Based Quiz, Academic Games, and Group Work.
Summative	Chapter Tests, Standards Mastery Assessments
Benchmark	Link It Benchmark
Alternative Assessments	Project Students can use the internet to explore the change in interest rates over the past 10 years, both in interest charged and interest earned. How can this affect an investment of $10,000? Now have students look at the current interest rates around the world and compare them with our… Are they better or worse? Convert all units to dollars during the comparisons. <>

Unit 2 Instructional and Supplemental Materials	
Instructional Materials	Concepts and Connections Chapters 4-5, Delta Math, CalcChat, Gimkit, Kahoot, Quizizz, Desmos, Edulastic, and Geogebra
Equipment	Ruler/Straight Edge, Calculator, and Computer with Internet Access.
Supplemental Unit Resources	A.REI.D.11 Two Squares are Equal A.SSE.A.2 Equivalent Expressions A.APR.B.2 The Missing Coefficient F.IF.7 Graphs of Power Functions F.IF.9 Throwing Baseballs
Intervention Resources	Tier II-III Interventions: Concepts and Connections

Unit 2 Instructional Best Practices	
• Establish mathematic goals to focus learning • Direct Instruction • Mini Lessons	• Gradual Release of Responsibility • Managing response rates • Checks for understanding

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• Identifying Similarities and Differences • Summarizing and Note Taking • Reinforcing Effort and Providing Recognition • Homework and Practice • Modeling • Cooperative Learning • Setting Objectives and providing Feedback • Cues, Questions, and Advance Organizers • Homework and Practice • Technology Infusion • Cooperative Learning • Checks for Understanding (Check for Understanding Strategies Description) • Closure	• Diagrams, charts and graphs • Coaching • Use and connect mathematical representations. • Visuals • Collaborative problem solving • Active engagement strategies • Establishing metacognitive reflection and articulation • Implement tasks that promote reasoning and problem solving.

Unit 2 Related Misconceptions/Clarifications	
• Students may forget to put polynomials in standard form before naming them. • Students may need to be reminded that they need to look from left to right when determining whether a function is increasing or decreasing. • Students will often mix up the terms quintic, quartic, and quadratic because they sound similar. • Students who confuse the signs of their zeros should write each factor in a separate equation equal to zero and then solve. • Students will often confuse expressions in the form of x2+ a2with a difference of squares. • Students may need to be reminded of the meaning of "consecutive integers". • Students will need to be reminded that the rational root theorem does not necessarily give the zeros of the equation. • Students may need to be reminded to use the conjugate root theorem to find out if they have found all of the roots of a polynomial.	• Students may need to be reminded that you can not take the nth root of a negative when n is even. • Students may need to review properties of exponents before applying them to radicals. • When foiling radical binomials, students should review multiplying radicals as they may struggle with the "last" step in the foiling method. • Students may confuse rationalizing the denominator method for a quotient of radical binomials in section 6-3 with the method applied in section 6-2. • Students may try to combine radicands when combining like radicals, however they remain unchanged due to the distributive property. • Students may need to be reminded that when squaring both sides of an equation they do not square each term but square the whole of both sides. • Students may get confused when working with function notation and mistake the parenthesis for meaning multiplication. Reading the functions allowed with the proper terminology will help. • Students may confuse the composition symbol with multiplication. • Students will need to be reminded that although they switch x and y to find the inverse of a general equation, they do not switch x and y when finding the inverse of a formula as it results in an untrue statement.

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Unit 2 Related Misconceptions/Clarifications	
	• As with previously learned translations, students may need to be reminded of how to identify a vertical and horizontal translation and the directions for both.

Unit 2 Interdisciplinary Connections
W.IW.11–12.2. Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. SL.UM.11–12.5. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. 9.1.12.PB.6: Describe and calculate interest and fees that are applied to various forms of spending, debt and saving.

Unit 2 Academic Vocabulary	
end behavior monomial multiplicity Pascal's Triangle polynomial function relative maximum relative minimum standard form of a polynomial function synthetic division turning point degree Remainder Theorem Rational Root Theorem expand Binomial Theorem	composite function inverse function nth root principal root radical equation radicand rational exponent rationalize the denominator square root equation square root function index simplest form like radicals

Unit 3- Exponential, Logarithmic, and Rational Functions; Date Analysis

Course: Algebra II	**Timeframe**: 25 Days

Unit 3 Focus/ Big Ideas

- Functions with values that are raised to variable powers are called exponential functions.
- The inverse of an exponential function is a logarithmic function.
- A rational number can be written as a ratio of two integers a/b, where b does not equal zero.
- Data analysis is the practice of organizing data to draw conclusions.

Unit 3 Pacing Guide- 25 days

Chapter		
Chapter 6	9 days	**Exponential and Logarithmic Functions** 6.1 Exponential Growth and Decay 6.2 The Natural Base e 6.3 Logarithms and Logarithmic Functions 6.4 Transformations of Exponential 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	8 days	**Rational Functions** 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 8	8 days	**Data Analysis and Statistics** 8.1 Using Normal Distributions 8.2 Populations, Samples, and Hypotheses 8.3 Collecting Data 8.4 Experimental Design 8.5 Making Inferences from Sample Surveys 8.6 Making Inferences from Experiments

Unit 3 Essential Questions	Unit 3 Enduring Understandings
● How do you model a quantity that changes regularly over time by the same percentage? ● How are exponents and logarithms related?	● You can represent repeated multiplication with a function in the form of y = abx where b is a positive number other than 1. ● Logarithms and exponents have corresponding properties.

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Unit 3 Essential Questions	Unit 3 Enduring Understandings
● How are exponential functions and logarithmic functions related?	● The exponential function y = bx is one-to-one, so its inverse x = by is a function. ● You can use logarithms to solve exponential equations. ● You can use exponents to solve logarithmic equations. ● The functions y = ex and y = ln(x) are inverse functions. ● The factor a in y = abx can stretch or compress, and possibly reflect the graph of the parent function y = bx.
● What kinds of asymptotes are possible for a rational function? ● Are two quantities inversely proportional if an increase in one corresponds to a decrease in the other? ● Are a rational expression and its simplified form equivalent?	● If a product is constant, where the constant is positive, a decrease in the value of one factor must accompany an increase in the value of the other factor. ● In a direct variation, two positive quantities either increase together or decrease together. In an inverse variation, as one quantity increases the other decreases. ● Quantities x and y are inversely proportional only if increasing x by the factor k (k0) means shrinking y by the factor 1k. ● Transformations of the parent reciprocal function include stretches, compressions (or shrinks), reflections, and horizontal and vertical translations. ● A rational function may have zero or one horizontal or oblique asymptote and zero or more vertical asymptotes. ● A rational function is a ratio of polynomial functions. ● If a function has a polynomial in its denominator, its graph has a gap at each zero of the polynomial. The gap could be a one-point hole in the graph, or it could be the location of a vertical asymptote for the graph. ● A rational function may have no asymptotes, one horizontal or oblique asymptote, and any number of vertical asymptotes. ● A reasonable graph for a rational function can be sketched by finding all intercepts and asymptotes. Sometimes a few extra points should be plotted to get a good sense of the shape of the graph. ● Much of what is true about multiplying and dividing fractions can be used to multiply and divide rational expressions. ● A rational expression is in simplest form when its numerator and denominator are polynomials that have no common divisors. ● Functions such as f(x)=x+ax2-a2and g(x)=1x-a, xa, are equivalent.

Unit 3 Essential Questions	Unit 3 Enduring Understandings
	• Much of what is true about operating with fractions can be used to operate with rational expressions. Rational expressions can be added or subtracted by first finding a common denominator - preferably the least common multiple (LCM) of the denominators. • The LCM of denominators is the product of their prime factors, each raised to the greatest power that occurs in any of the expressions. • Solving an equation containing rational expressions begins by multiplying each side by the least common denominator of the rational expressions. Doing this, however, can introduce extraneous solutions.

Unit 3 NJSLS Standards

Chapter	Standards	
Chapter 6	• A.CED.A.2 • A.SSE.A.1.b • A.SSE.A.2 • F.BF.B.3 • F.BF.B.4.a • F.BF.B.5 • F.IF.C.7.e • F.LE.A.4	• Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. • Interpret complicated expressions by viewing one or more of their parts as a single entity. • Use the structure of an expression to identify ways to rewrite it. • 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. • 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. • Use the inverse relationship between exponents and logarithms to solve problems involving logarithms and exponents. • Graph exponential and logarithmic functions, showing intercepts and end behavior. • Understand the inverse relationship between exponents and logarithms.
Chapter 7	• A.APR.D.6 • A.APR.D.7 • A.CED.A.1 • A.CED.A.2 • A.REI.A.2 • F.BF.B.3 • F.IF.C.7.d	• 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. • 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. • 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. • Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

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		• Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. • 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. • Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
Chapter 8	• S.ID.A.4 • S.IC.A.1+ • S.IC.A.2+ • S.IC.B.3+ • S.IC.B.4+ • S.IC.B.5+ • S.IC.B.6+	• Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. • + Understand statistics as a process for making inferences about population parameters based on a random sample from that population. • + Decide if a specified model is consistent with results from a given data-generating process • + Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. • + Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling. • + Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. • + Evaluate reports based on data. (e.g. interrogate study design, data sources, randomization, the way the data are analyzed and displayed, inferences drawn and methods used; identify and explain misleading uses of data; recognize when arguments based on data are flawed).

Unit 3 Instructional Plan

Pre-Assessment
Common Pre-assessment given prior to this unit to build a base of student understanding.

Unit 3 Evidence of Learning-Assessments	
Formative	Daily Warm-up, Daily Closure Activity, Daily Teacher Observations, Class Participation, Homework, Gimkits, Kahoots, Quizizz, Paper Based Quiz, Academic Games, Group Work, Mentimeter, and ASSISTments.
Summative	Chapter Tests, Standards Mastery Assessments
Benchmark	Link It Benchmark
Alternative Assessments	Project Students can research population and waste production in the US to find linear models to make predictions for future expectations. <>

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Unit 3 Instructional and Supplemental Materials		
Instructional Materials	Concepts and Connections Chapters 6-8, Delta Math, CalcChat, Khan Academy, Gimkit, Kahoot, Quizizz, Desmos, Edulastic, and Geogebra	
Equipment	Calculator and Computer with Internet Access.	
Supplemental Unit Resources	A.REI.D.11 Two Squares are Equal A.SSE.B.3c Forms of exponential expressions F.IF.7 Graphs of Power Functions F.IF.C.8b Carbon 14 dating in practice I F.IF.9 Throwing Baseballs F.LE.A.4 Carbon 14 dating	F.BF.1 A Sum of Functions A.APR.D.6 Combined Fuel Efficiency A.REI.11 Ideal Gas Law A.REI.2 Canoe Trip A.CED.1 An Extraneous Solution
Intervention Resources	Tier II-III Interventions: Concepts and Connections	

Unit 3 Instructional Best Practices	
• Establish mathematic goals to focus learning • Direct Instruction • Mini Lessons • Identifying Similarities and Differences • Summarizing and Note Taking • Reinforcing Effort and Providing Recognition • Homework and Practice • Modeling • Cooperative Learning • Setting Objectives and providing Feedback • Cues, Questions, and Advance Organizers • Homework and Practice • Technology Infusion • Cooperative Learning • Checks for Understanding (Check for Understanding Strategies Description) • Closure	• Gradual Release of Responsibility • Managing response rates • Checks for understanding • Diagrams, charts and graphs • Coaching • Use and connect mathematical representations. • Visuals • Collaborative problem solving • Active engagement strategies • Establishing metacognitive reflection and articulation • Implement tasks that promote reasoning and problem solving.

Unit 3 Related Misconception(s) /Clarifications	
• Students will often try to plug in a percentage for a rate before turning the value into a decimal.	• Students often mix up the variations of direct and inverse variation. • Use a graph to help students identify the type of variation displayed in a table.

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Unit 3 Related Misconception(s) /Clarifications	
• Students may need to be reminded that if there is no value for a, then a = 1. • Students may have trouble identifying the parent function when describing translations and transformations. It helps to tell them to look at the value being taken to the power of x. • When converting from exponential to logarithmic form and vice versa, having students write out the formula will help reduce errors. • Students may need to be reminded that they can take the logarithm of both sides of both types of exponential equations, even ones that can be written with a common base. • Students may need to be reminded that natural logarithms have the same properties as other logarithmic functions.	• There are often times where students struggle to break down a sentence describing combined variation and express it in equation form. • It helps to relate the general form of the reciprocal function to the vertex form of a quadratic equation. • Error Prevention: If students translate the graph of a reciprocal function vertically before they reflect it in the x-axis, they will likely end up with the wrong graph. Point out the difference between adding k inside the parentheses and outside the parentheses. • Students often want to divide out individual terms in the numerator and denominator without factoring first. Take time to illustrate why this is an incorrect way to simplify a rational expression. • Error Prevention: Students may not realize that a graph can cross its horizontal asymptote. A graph will never cross a vertical asymptote. • Students often mix up LCM and GCF. • Error Prevention: When multiplying expressions to get a common denominator, students should multiply out the numerators but leave the denominators factored. • Error Prevention: Remind students that when adding rational expressions, it is necessary to multiply each ratio by a form of 1 so as not to change the expression.

Unit 3 Interdisciplinary Connections
W.IW.11–12.2. Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. Career Readiness, Life Literacies and Key Skills CRP7. Employ valid and reliable research strategies.

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Unit 3 Integration of Technology

8.2.12.ETW.1: Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product.

Unit 3 Academic Vocabulary	
asymptote Change of Base Formula common logarithm exponential equation exponential function exponential growth exponential decay logarithm logarithmic equation logarithmic function natural base exponential functions natural logarithmic function	Combined Variation Complex Fraction Continuous Graph Discontinuous Graph Inverse Variation Joint Variation Point of Discontinuity Removable Discontinuity Non-Removable Discontinuity Rational Equation Rational Expression Rational Function Reciprocal Function Branch Simplest Form

Exponential, Logarithmic and Rational Functions - Unit 4

Course: Algebra II	**Timeframe**: 20 Days

Unit 4 Focus/ Big Ideas

- Trigonometry is the branch of mathematics dealing with relationships between side lengths and angles of a triangle.
- A sequence is an ordered list of numbers.
- Numbers in a sequence often follow a pattern that can be described by a rule.
- A matrix is a rectangular array of numbers.

Unit 4 Pacing Guide- 25 days

Chapter		
Chapter 9	10 days	**Trigonometric Rations and Functions** 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

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		9.5 Graphing Other Trigonometric Functions 9.6 Modeling with Trigonometric Functions 9.7 Using Trigonometric Identities 9.8 Using Sum and Difference Formulas
Chapter 10	7 days	**Sequence and Series** 10.1 Defining and Using Sequences and Series 10.2 Analyzing Arithmetic Sequences and Series 10.3 Analyzing Geometric Sequences and Series 10.4 Finding Sums of Infinite Geometric Series 10.5 Using Recursive Rules and Sequences
Chapter 11	8 days	**Matrices** 11.1 Basic Matrix Operations 11.2 Multiplying Matrices 11.3 Determinants and Cramer's Rule 11.4 Inverse Matrices

Unit 4 Essential Questions	Unit 4 Enduring Understandings
● How can you represent the terms of a sequence explicitly? ● How can you represent the terms of a sequence recursively? ● What are equivalent explicit and recursive definitions for an arithmetic sequence? ● How can you model a geometric sequence? ● How can you model the sum of a geometric sequence?	● If the numbers in a list follow a pattern, it may be possible to relate each number in the list to its numerical position in the list with a rule. ● A sequence can be defined explicitly by describing its nth term with a formula using n or recursively by stating its first term and a formula for its nth term using the (n-1) term. ● In an arithmetic sequence, the difference between any two consecutive terms is always the same number. An arithmetic sequence can be built by adding the same number to each term. ● an=a+(n-1)d and a1=a, an=an-1+d for n>1 define the same arithmetic sequence, a, a+d, a+2d,… ● In a geometric sequence, the ratio of any term (after the first) to its preceding term is a constant value, no matter what two terms are compared. A geometric sequence can be built by multiplying each term by that constant. ● A geometric sequence can be modeled explicitly or recursively. ● When two terms and the number of terms in a finite arithmetic sequence are known, the sum of the terms can be found. ● Just as with finite arithmetic series, the sum of a finite geometric series can be found using a formula. It is necessary to know the first term, the number of terms, and the common ratio.

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Unit 4 Essential Questions	Unit 4 Enduring Understandings
	• A geometric sequence can be modeled explicitly or recursively. The sum of its first n terms is a1(1-rn)1-r.
• How are measures of central tendency different from standard deviation?	• Data sets can be described using various statistical measures, depending on what characteristics are being studied. • Standard deviation is a measure of how far the numbers in a data set deviate from the mean. • You can get good statistical information about a population by studying a sample of the population. • Normal Distributions model many common natural phenomena, such as human height, weight, and blood pressure.

	Unit 4 NJSLS Standards	
Chapter	**Standards**	
Chapter 9	• F.BF.B.3 • F.IF.C.7.f+ • F.TF.A.1+ • F.TF.A.2+ • F.TF.B.5+ • F.TF.C.8+ • F.TF.C.9	• Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k)n for specific values of k (both positive and negative); find the value of k given then graphs. • + Graph trigonometric functions, showing period, midline, and amplitude. • + Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle. • + 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. • + Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline. • + Prove the Pythagorean identity sin2 (θ) + cos2 (θ) = 1 and use it to find sin(θ), cos(θ), or tan(θ) given sin(θ), cos(θ), or tan(θ) and the quadrant of the angle. • Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.
Chapter 10	• A.SSE.B.4+ • F.BF.A.2 • F.IF.A.3	• +Derive and/or explain the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments. • Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms. • Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.
Chapter 11	• N.VM.C.6 • N.VM.C.7 • N.VM.C.8	• Use matrices to represent and manipulate data, e.g., as when all of the payoffs or incidence relationships in a network.

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	• N.VM.C.9 • N.VM.C.10 • N.VM.C.12 • A.REI.C.8 • A.REI.C.9	• Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled. • Add, subtract, and multiply matrices of appropriate dimensions. • Understand that, unlike the multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties. • 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. • Work with 2 × 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area. • Represent a system of linear equations as a single matrix equation in a vector variable. • Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater).

Unit 4 Instructional Plan

Pre-Assessment
Common Pre-assessment given prior to this unit to build a base of student understanding.

Unit 4 Evidence of Learning-Assessments	
Formative	Daily Warm-up, Daily Closure Activity, Daily Teacher Observations, Class Participation, Homework, Gimkits, Kahoots, Quizizz, Paper Based Quiz, Savvas Realize Lesson Checks, Academic Games, and Group Work.
Summative	Chapter Tests, Standards Mastery Assessments
Benchmark	Link It Benchmark
Alternative Assessments	Project • Students can examine wind energy from different countries and create exponential models over a course of 10 to 15 years. # • Students can research and study the effects of Hurricane Fran when it hit North Carolina in 1996. They can use the information from the National Weather Service to create exponential models and answer questions as it relates to the hurricane's devastation. <>

Unit 4 Instructional and Supplemental Materials	
Instructional Materials	Concepts and Connections Chapters 9-11, Delta Math, CalcChat, Khan Academy, Gimkit, Kahoot, Quizizz, Desmos, Edulastic, and Geogebra.
Equipment	Ruler/Straight Edge, Calculator, and Computer with Internet Access.

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Unit 4 Instructional and Supplemental Materials		
Supplemental Unit Resources	A.SSE.B.4 Course of Antibiotics F.BF.A.2 Snake on a Plane F.LE.A.2 Rumors LGBTQ Scientists-Engineers-Mathematicians +	S.IC.A.1 School Advisory Panel S.IC.A.2 Sarah, the Chimpanzee S.IC.B.3 Strict Parents S.IC.B.4 Margin of Error for Estimating a Population Mean Career Averages <>
Intervention Resources	Tier II-III Interventions: Concepts and Connections	

Unit 4 Instructional Best Practices	
• Establish mathematic goals to focus learning • Direct Instruction • Mini Lessons • Identifying Similarities and Differences • Summarizing and Note Taking • Reinforcing Effort and Providing Recognition • Homework and Practice • Modeling • Cooperative Learning • Setting Objectives and providing Feedback • Cues, Questions, and Advance Organizers • Homework and Practice • Technology Infusion • Cooperative Learning • Checks for Understanding (Check for Understanding Strategies Description) • Closure	• Gradual Release of Responsibility • Managing response rates • Checks for understanding • Diagrams, charts and graphs • Coaching • Use and connect mathematical representations. • Visuals • Collaborative problem solving • Active engagement strategies • Establishing metacognitive reflection and articulation • Implement tasks that promote reasoning and problem solving.

Unit 4 Related Misconception(s) /Clarifications	
• Students often misunderstand the subscript format to naming terms in a sequence. • Towards the end of the Module, students will often mix up the formulas. • When applying the Geometric Mean, students will forget that some sequences could be positive or negative.	• Students will mix up Mean, Median and Mode. • When finding the median or the quartiles, some students freeze up and don't know what to do when there are an even number of numbers. • Students often forget to reset the settings on their calculator. • Students sometimes forget that you can obtain the variance in the calculator by squaring the standard deviation.

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• When writing a series in summation notation, watch for students who confuse n and an. The lower limit to the upper limit is the number of terms, not the values of the terms. • Students often think that all series in summation notation start at n = 1, but this is not always the case. • Error Prevention: Have students check whether a series is arithmetic before using the formula for finding the sum of a finite arithmetic series. If a series is not arithmetic, look for a pattern in the terms. • When using a calculator to find the sum of a series, be sure to instruct the students not to round their answer until the very end of the problem. • Sometimes students do not remember to change the rate from a percent to a decimal before inputting it into the formula.	• Students may need extra practice differentiating between the different types of samples and surveys.

Unit 4 Interdisciplinary Connections

W.IW.11–12.2. Write informative/explanatory texts (including the narration of historical events, scientific procedures/ experiments, or technical processes) to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

SL.PI.11–12.4 Present information, findings and supporting evidence clearly, concisely, and logically. The content, organization, development, and style are appropriate to task, purpose, and audience.

SL.II.11–12.2. Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

Career Readiness, Life Literacies and Key Skills CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.

Unit 4 Academic Vocabulary	
Arithmetic Sequence Arithmetic Series Common Difference Common Ratio	Measure of central tendency Mean Median Mode

Unit 4 Academic Vocabulary	
Converge Diverge Explicit Formula Geometric Series Geometric Sequence Limits Recursive Formula Sequence Terms of a Sequence Arithmetic Mean Geometric Mean Series Finite Series Infinite Series	Bimodal Outlier Range of a set of Data Quartiles Interquartile Range Box and Whisker Plot Percentile Measure of Variation Variance Standard Deviation Population, Sample Convenience Sample Self-Selected Sample Systematic Sample Random Sample Bias Observational Study Controlled Experiment Survey Discrete Probability Distribution Continuous Probability Distribution Normal Distribution Margin of Error Confidence Interval Sample Proportion Z-Score

Modifications/ Accommodations for Special Education Students	Accommodations for 504 Students	Modifications for At-Risk Students
• Modify activities/assignments/projects • Breakdown activities/assignments/projects/assessments into manageable units • Additional time to complete activities/assignments/projects/assessments	• Breakdown activities/assignments/projects/assessments into manageable units • Additional time to complete activities/assignments/projects/assessments • Provide an option for alternative activities/assignments/projects/assessments	• Place near positive peers • Check-ins with student • Verbal instructions written and left on board • Chunk directions • Have student repeat classroom expectations • Reword instructions if needed • Provide examples on board

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Modifications/ Accommodations for Special Education Students	Accommodations for 504 Students	Modifications for At-Risk Students
• Provide an option for alternative activities/assignments/projects/assessments • Allow student to receive reading text in various forms (written, verbal, audio) • Pre-teach new vocabulary • Modify Content • Modify Amount of work given • Modify Assessment • Modify Homework • Re-teach skill if needed • Allow student to make test corrections or re-take assessment • Adjust Pacing of Content • Small Group Instruction • Individual Intervention/Remediation • Additional Support Material • Lower-Level Text • Guided Notes • Graphic Organizers *** Implementation based on Student's IEP**	• Small Group Instruction • Intervention/Remediation • Individual Intervention/Remediation • Additional Support Materials • Guided Notes • Graphic Organizers • Tutoring *** Implementation based on Student's 504**	• Provide scaffolding • Assist with transitions • Identify go-to students • for organizational support • Check and sign planner • Weekly organization time • Allow extra time as needed • Oral instructions repeated and written on board

English Language Learners	Extensions for Gifted Students
• Vocabulary instruction • Pre-Reading strategies • Graphic organizers • Reading strategies • Tutoring • Pair students up with peers • Provide visual representation	• Activities/assignments/projects/assessments • Provide an option for alternative instructional activities • Higher-level content • Adjust pacing of content • Small group enrichment • Individual enrichment • Higher-level text

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Required Activities	Suggested Activities
● Essential Questions should be posted and referenced throughout class ● Do Now/Warm-Up ● Whole Group ● Small Groups ● Guided Practice ● Independent Practice ● Identify and review objectives at beginning, middle and end of lesson ● Learning Stations ● Strategies to assist any struggling student ● Closure/ Reflection	● Projects ● Academic Games

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