Algebra 2 Honors: Unit 2

Marking Period	Unit Title	Recommended Instructional Days
1 and 2	**Polynomial functions**	**18-22 days**

Domain: Number and Quantity, Algebra, Functions

NJSLS Strand:

Key:

Major Cluster
Supporting Cluster
Additional Cluster

N-CN.C.7 Solve quadratic equations with real coefficients that have complex solutions,
N-CN.C.8 (+) Extend polynomial identities to the complex numbers. *For example, rewrite $x^2 + 4$ as $(x + 2i)(x – 2i)$.*
N-CN.C.9 (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.
A-SSE.A.2 Use the structure of an expression to identify ways to rewrite it. *For example, see $x^4 – y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 – y^2)(x^2 + y^2)$.*
A-APR.A.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of

Progress Indicator:
Tests • Quizzes • Practice problems for homework • Online textbook • Worksheets • Leveled assessments

Recommended Activities, Investigations, Interdisciplinary Connections, and/or Student Experiences to Explore NJSLS-CLKS within Unit

Essential Question/s:

- **What can the rule for a polynomial function reveal about its graph, and what can the graphs of polynomial functions reveal about the solutions of polynomial equations?**
- **What does division of polynomials tell us about a polynomial function?**
- **How is the algebraic representation different for the vertical and horizontal transformations?**

Activity Description:
Graphing Polynomial functions
End Behavior using limit notation
Adding and Subtracting Polynomials
Pascal's Triangle and the Binomial Theorem
Multiplying Polynomials
Synthetic and Long Division of Polynomials
Factoring Polynomials
Remainder and Factor Theorem
Zeros of Polynomial Functions
Rational Root Theorem
Fundamental Theorem of Algebra
Conjugate Root Theorem

addition, subtraction, and multiplication; add, subtract, and multiply polynomials. **A-APR.B.2** Know and apply the Remainder Theorem: For a polynomial p(x) and a number *a*, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x-a) is a factor or p(x). **A-APR.B.3** Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial. **A-APR.C.4 (+)** Prove polynomial identities and use them to describe numerical relationships. *For example, the difference of two squares; the sum and difference of two cubes; the polynomial identity* $(x^2+y^2)^2 = (x^2-y^2)^2 + (2xy)^2$ *can be used to generate Pythagorean triples.* **A-APR.C.5** (+) Know and apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle. **A-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.		Transformations of Polynomial Functions Polynomial Regression **Interdisciplinary Connections: Science** Cardiac output is the amount of blood pumped through the heart. The output is measured by a technique called dye dilution. A doctor injects dye into a vein near the heart and measures the amount of dye overtime. The cardiac output of a particular patient can be approximated by the function $f(t) = 0.000468t^4 – 0.016t^3 + 0.095t^2 + 0.806t$, where t represents time (in seconds after injection) and f(t) represents the concentration of dye (in milligrams per liter). Evaluate f(t) for t = 4 and t = 17, and describe what the values of the function represent. Answer: f(4) = 3.8398; the concentration of dye after 4 seconds f(17) = 1.6368; the concentration of dye after 17 seconds **Content: Concentration of drugs in the bloodstream** **NJSLS#: HS-LS1-3** **Example Tasks:** **Task 1:** A box in the shape of a rectangular prism has a width that is 5 inches greater than the height and a length that is 2 inches greater than the width. Write a polynomial expression in standard form for the

A-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. **A-CED.A.2** Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. **A-CED.A.3** Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods. **A-REI.A.1** Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. **A-REI.D.11** Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find solutions approximately; e.g., using technology to graph functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational,		volume of the box. Explain the meaning of any variables used **Answer:** Let x represent the height of the box. The volume of the box is $x(x+5)(x+7) = x^3 + 12x^2 + 35x$ **Task 2:** Given that the factored form of a polynomial function is $f(x) = (x+a)(x-b)(x+c)(x-d)$, where a, b, c, and d are positive numbers, describe the graph of the function in the coordinate plane including intercepts and end behavior. **Answer:** The graph has x-intercepts at $(-a, 0)$, $(b, 0)$, $(-c, 0)$, and $(d, 0)$. The y-intercept of the graph is $(0, abcd)$. $\lim_{x \to -\infty}(f(x)) = \infty$ $\lim_{x \to \infty}(f(x)) = \infty$ **Task 3:**

absolute value, exponential, and logarithmic functions.*

F-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 in 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.**

F-IF.C.7 Graph functions expressed symbolically and show key features if the graph, by hand in simple cases and using technology for more complicated cases.
c. Graph polynomial functions, identifying zeros when suitable factorizations are available, showing end behavior.

F-BF.A.1 Write a function that describes a relationship between two quantities.

F-IF.A.3 Identify the effect on the graph of replacing f(x) by f(x) + k, kf(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.*

Write the expression $\frac{x^4 + x^3 - 3x^2 - 10x + 2}{x^2 + 3x + 3}$ as $Q(x) + \frac{R(x)}{x^2 + 3x + 3}$, where $Q(x)$ is the quotient with degree 2 and $R(x)$ is the remainder. Show your work.

Answer:

Using long division,

$$\begin{array}{r} x^2 - 2x + 0 \\ x^2 + 3x + 3 \overline{)\, x^4 + x^3 - 3x^2 - 10x + 2} \\ \underline{x^4 + 3x^3 + 3x^2} \\ -2x^3 - 6x^2 - 10x \\ \underline{-2x^3 - 6x^2 - 6x} \\ -4x + 2 \end{array}$$

So in the requested form the expression can be written as: $x^2 - 2x + \frac{-4x + 2}{x^2 + 3x + 3}$

Task 4:

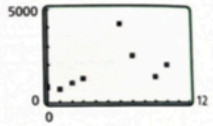
The table shows the opening value of a stock index on the first day of trading in various years. Use a polynomial model to estimate the value on the first day of trading in 2002.

Year	Price ($)	Year	Price ($)
1994	774	2000	4186
1995	751	2001	2474
1996	1053	2003	1347
1997	1293	2004	2011

Answer:

Step 1 Choose the degree of the polynomial model.

Let x represent the number of years since 1994. Make a scatter plot of the data.



The function appears to be cubic or quartic. Use the regression feature to check the R^2-values.

cubic: $R^2 \approx 0.6279$ quartic: $R^2 \approx 0.8432$

The quartic function is a more appropriate choice.

Step 2 Write the polynomial model.

The data can be modeled by
$f(x) = 9.27x^4 - 191.56x^3 + 1168.22x^2 - 1702.58x + 999.60$

Step 3 Find the value of the model corresponding to 2002.

2002 is 8 years after 1994. Substitute 8 for x in the quartic model.

$f(x) = 9.27(8)^4 - 191.56(8)^3 + 1168.22(8)^2 - 1702.58(8) + 999.60 = 2036.24$

Based on the model, the opening value was about \$2036.24 in 2002.

At the end of each topic please review the Assessment Practice and Performance Tasks questions.

ASSESSMENT PRACTICE

30. Are polynomials open or closed under each operation? Classify each operation as *open* or *closed*.

a. addition

b. subtraction

c. multiplication

d. division

Performance Task Consider the polynomial functions $P(x) = x^2 - 4$ and $R(x) = -x^2 - 2x$.

Part A Write and simplify a polynomial function $T(x)$ that is the product of P and R.

Part B Copy and complete the table of values for all three functions.

x	$P(x)$	$R(x)$	$T(x)$
–3			
–2			
–1			
0			
1			
2			
3			

Part C Graph the functions on the same coordinate grid.

Part D How do the zeros of T relate to the zeros of P and R?

Part E Explain how you can identify the intervals in which T is positive by analyzing the R and P.

Spot Light on: Climate Change

Global warming due to fossil fuel emissions, is believed to be one of the causes for climate change.

		Therefore, there is an increased interest in the use of renewable and cleaner sources of energy. This lesson plan will help improve students' literacy in clean energy sources while enabling them to practice Formula Substitution. It includes resources to teach your students about the components of formulas, and substitution in a formula using the energy equation for wind turbines, to enable them to understand the energy available from wind. **Climate Change Activity** Climate Change Example: Students may create equations and/or inequalities to represent the economic impact of climate change. Climate Change Example: Students may represent constraints describing the economic impact of climate change by equations, inequalities, and/or by systems of inequalities, and interpret solutions as viable or nonviable options.
Mathematics Practices		
1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reason of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.		

Social and Emotional Learning: ***Competencies***	**Social and Emotional Learning:** ***Sub-Competencies***	
Self- awareness Social Awareness Self- Management Relationship Skills Responsible Decision-Making	Recognizing the importance of self-confidence in handling daily tasks and challenges. Demonstrate an awareness of the expectations for social interactions in a variety of ways. Demonstrate an understanding of the need for mutual respect when viewpoints differ. Recognize the skills needed to establish and achieve personal and educational goals. Utilize positive communication and social skills to interact effectively with others. Develop, implement, and model effective problem solving and critical thinking skills.	

Assessments (Formative) ***To show evidence of meeting the standard/s, students will successfully engage within:***	**Assessments (Summative)** ***To show evidence of meeting the standard/s, students will successfully complete:***
Formative Assessments: ● Entry and Exit Slips ● Quizzes ● Self Assessments	**Benchmarks:** ● Chapter Tests ● Projects ● LinkIT

	<u>Summative Assessments:</u> ● District Assessments ● Standardized Tests

Differentiated Student Access to Content: Teaching and Learning *Resources/Materials*				
Core Resources		**Alternate Core Resources *IEP/504/At-Risk/ESL***	**ELL Core Resources**	**Gifted & Talented Core Resources**
● Savvas Envision ● Achieve the core ● Khan Academy ● Desmos		● Skill building worksheets ● Math Manipulatives	● Dictionary for native languages ● Videos in their native language.	● Leveled Assessments ● Enrichment worksheets

Supplemental Resources
Technology: ● **Chromebooks, Graphing Calculators, smartboards** **Other:** ● **Zoom and Google Meets, Schoology, Interactive Textbooks**

Differentiated Student Access to Content: Recommended *Strategies & Techniques*			
Core Resources	**Alternate Core Resources *IEP/504/At-Risk/ESL***	**ELL Core Resources**	**Gifted & Talented Core**
● **Deliver instruction utilizing varied learning styles including audio, visual, and tactile/kinesthetic, provide individual instruction as needed, modify assessments and/or rubrics, repeat**	● **Utilize a multi-sensory (VAKT) approach during instruction, provide alternate presentations of skills by varying the**	● **Extend time requirements, preferred seating, positive reinforcement, check often for understanding/review, oral/visual**	● **Create an enhanced set of introductory activities, integrate active teaching/learning opportunities, incorporate**

	method (repetition, simple explanations, additional examples, modeling, etc.), modify test content and/or format, allow students to retake test for additional credit, provide additional times and preferential seating as needed, review, restate and repeat directions, provide study guides, and/or break assignments into segments of shorter tasks.	**directions/prompts when necessary, supplemental materials including use of an online bilingual dictionary, and modified assessment and/or rubric.**	**authentic components, propose interest-based extension activities, and connect student to related**

NJSLS CAREER READINESS, LIFE LITERACIES & KEY SKILLS	**Disciplinary Concept: Creativity and Innovation**	
	Core Ideas:	**Solutions to the problems faced by a global society require the contribution of individuals with different points of view and experiences.**
	Performance Expectation/s:	**99.4.12.GCA.1: Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).**
	Career Readiness, Life Literacies, & Key Skills Practices	
	Act as a responsible and contributing community member and employee. **Attend to financial well-being.**	

	Consider the environmental, social and economic impacts of decisions. **Demonstrate creativity and innovation.** **Utilize critical thinking to make sense of problems and persevere in solving them.** **Model integrity, ethical leadership and effective management.** **Plan education and career paths aligned to personal goals.** **Use technology to enhance productivity, increase collaboration and communicate effectively.** **Work productively in teams while using cultural/global competence.**

New Jersey Legislative Statutes and Administrative Code (place an "X" before each law/statute if/when present within the curriculum map)									
	Amistad Law: *N.J.S.A. 18A 52:16A-88*		Holocaust Law: *N.J.S.A. 18A:35-28*		LGBT and Disabilities Law: *N.J.S.A. 18A:35-4.35*		Diversity & Inclusion: *N.J.S.A. 18A:35-4.36a*	X	Standards in Action: *Climate Change*