

Unit 03: Polynomial Functions

Content Area: **Mathematics**
Course(s):
Time Period: **Marking Period 2**
Length: **1.5 weeks**
Status: **Published**

Brief Summary of Unit

Students will examine functions with degree greater than two. Through exploration on the graphing calculators, students will find roots and discuss the distinguishable characteristics of cubics and quartics including end behavior, root multiplicities and local extrema. Without graphing calculators, students will utilize the rational root theorem and synthetic division to find roots and graph the related function.

Standards

CS.K-12.3.a	Identify complex, interdisciplinary, real-world problems that can be solved computationally.
CS.K-12.3.b	Decompose complex real-world problems into manageable sub-problems that could integrate existing solutions or procedures.
LA.K-12.NJSLSA.L4	Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.
LA.K-12.NJSLSA.L5	Demonstrate understanding of word relationships and nuances in word meanings.
MA.F-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.
MA.F-IF.C.7c	Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
MA.N-CN.A.3	Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.
MA.N-CN.C.7	Solve quadratic equations with real coefficients that have complex solutions.
MA.N-CN.C.8	Extend polynomial identities to the complex numbers.
MA.N-CN.C.9	Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.
MA.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.
MA.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.
TEC.K-12.8.1	All students will use computer applications to gather and organize information and to solve problems.
TEC.K-12.8.2	All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world as they relate to the individual society, and the environment.
WORK.K-12.9.1	All students will develop career awareness and planning, employability skills and

foundational knowledge necessary for success in the workplace.

WORK.K-12.9.2

All students will develop career awareness and planning, employability skills and foundational knowledge necessary for success in the workplace.

Transfer

- Finding the roots of a polynomial are helpful while solving real world scenarios of jumping or diving.
- Using a graphing calculator, students can get an exact visual of what the function should look like, and what its roots are.

Essential Questions

- How are higher-order functions graphed and what strategies can be used to solve higher-order equations?
- What are the distinguishable characteristics of functions with degree greater than two?

Essential Understandings

- A polynomial function can be determined if the zeros of the function are known. The equation of the polynomial can be determined if a sketch of the graph is given, noting the zeros and whether the leftmost portion of the graph is positive or negative.
- An equation with odd degree has at least one real root.
- Evaluating a function at a given value can be accomplished by direct substitution or synthetic substitution.
- Graphing calculators can be used to find roots of a polynomial. Once a root is found, the polynomial can be factored by synthetic division.
- Knowing that $f(a)$ is positive and $f(b)$ is negative is enough to show that there must be a root somewhere on the interval $[a, b]$ for any polynomial function.
- Synthetic division is a simplified version of long division.
- The multiplicity of a root determines if the graph is tangent at that point or if the graph has a horizontal tangent.
- The Rational Root Theorem and synthetic division can be used to factor a polynomial of degree 3 or higher.
- The Remainder Theorem and the Factor Theorem used in conjunction with synthetic substitution/division can help one determine if 'a' is a zero or 'x-a' is a factor.
- The sum and product of roots can be used to find the equation of any quadratic. This can be further extended to find the equation of polynomials of degree 3 or higher.

Students Will Know

- How to graph a polynomial given its roots and/or equation.
- How to perform long and synthetic division of polynomials.
- The effect of the degree on the number of roots that a polynomial can have.

- The Fundamental Theorem of Algebra and Complex Conjugates Theorem.
- The Remainder Theorem, Factor Theorem and Rational Root Theorem.

Students Will Be Skilled At

- Describing the execution and uses of the Complex Conjugates Theorem.
- Describing the execution and uses of the Factor Theorem.
- Describing the execution and uses of the Fundamental Theorem of Algebra.
- Describing the execution and uses of the Rational Root Theorem.
- Describing the execution and uses of the Remainder Theorem.
- Graphing roots for a polynomial equation.
- Identifying how the degree of a polynomial's roots effect the graph.
- Performing any kind of division on polynomials.

Evidence/Performance Tasks

Assessments

- **Formative:** Daily assessments using examples from class notes, NJSLA test bank problems, and/or Albert/AP Classroom assessments
 - **Summative:** Teacher-created assessments, NJSLA test bank problems, Big Ideas Math online platform problems, Albert/AP Classroom and/or Big Ideas Math unit assessments
 - **Benchmark:** IXL or teacher created diagnostic assessments in addition to unit assessments from Big Ideas Math
 - **Alternative Assessments:** Student-centered activities such as scavenger hunts, various projects involving real world applications, and differentiated learning tasks in Khan Academy, DeltaMath, and IXL
- Find a maximum or minimum of a polynomial with and without graphing calculators.
 - Identify the equations of a polynomial given its graphs.
 - Students will use graphing calculators to explore roots of a polynomial and make conjectures about how to solve complex equations. They will also discover the effects of roots with different multiplicities and give general rules about how to graph any polynomial.
 - Use a graphing calculator to find one root of a cubic and use synthetic division to find the others.
 - Use synthetic division to factor polynomials.
 - Answer essential questions
 - Classwork and homework that assess the essential questions
 - Graph a polynomial using its equation
 - Provide alternative means of assessments for certain students

- Tests and quizzes that assess the essential questions
- Written assignments that assess the essential questions that involves providing explanations
- Graph a polynomial using its equation.
- Evaluate expressions using long and synthetic division.
- Identify double and triple roots and their significance to the graphs.

Learning Plan

- Determining maximum/minimum values in verbal problem solving situations.
- Determining an equation if the roots are known: apply the Complex Conjugate Theorem and the idea that a quadratic equation can be perceived as $x^2 - (\text{sum of roots})x + \text{product of the roots} = 0$.
- Graphing a function with degree greater than 2 if the roots are known.
- Graphing a function with degree greater than 2 if the roots are not known: apply the Rational Root Theorem and synthetic division to find the roots.
- Preview the essential questions and connect to learning throughout the unit.
- Synthetic Substitution, Synthetic Division, Remainder Theorem, Factor Theorem.
- The graphing calculator should be used as an exploratory device during this chapter. Students should utilize the graphing calculator to make conjectures about the properties of polynomials, including multiplicity of roots, imaginary solutions and end behavior.

Materials

Core instructional materials: [Core Book List](#) including PreCalculus Enhanced with Graphing Utilities, Sullivan, Savvas

Supplemental materials: Khan Academy, Edia, and DeltaMath

- District approved textbook
- Khan Academy
- Teacher created activities
- Teacher created notes
- Whiteboard tables

Suggested Strategies for Modifications

[Possible accommodations/modification for CP PreCalc & Trig](#)

