Lesson 1.13 - Synthetic Division

Learning Objectives: SWBAT

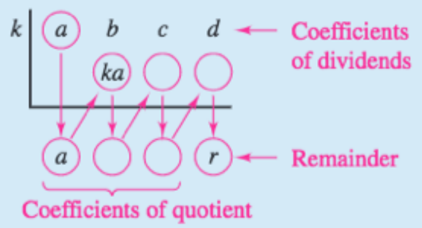
- Divide polynomials using the process of synthetic division

Background

There is a nice shortcut for long division of polynomials when dividing by divisors of the form $x - k$. The shortcut is called **synthetic division.** The pattern for synthetic division of a cubic polynomial is summarized as follows. (The pattern for higher-degree polynomials is similar.)

Synthetic Division (of a Cubic Polynomial)

To divide $ax^3 + bx^2 + cx + d$ by $x - k$, use the following pattern.



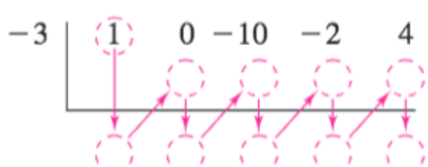
Vertical pattern: Add terms.
Diagonal pattern: Multiply by k.

This algorithm for synthetic division works *only* for divisors of the form $x - k$. Remember that $x + k = x - (-k)$.

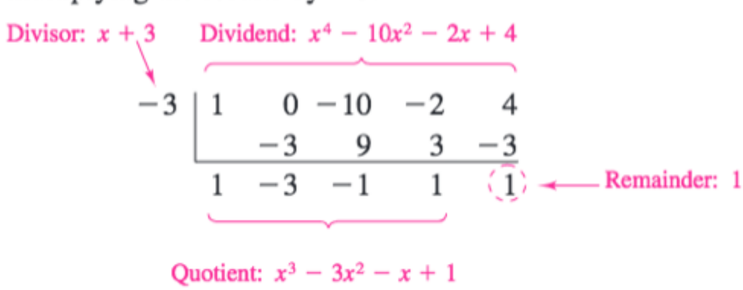
Example Use synthetic division to divide $x^4 - 10x^2 - 2x + 4$ by $x + 3$.

Solution

You should set up the array as follows. Note that a zero is included for each missing term in the dividend.



Then, use the synthetic division pattern by adding terms in columns and multiplying the results by -3.



So, you have

$$\frac{x^4 - 10x^2 - 2x + 4}{x + 3} = x^3 - 3x^2 - x + 1 + \frac{1}{x + 3}.$$

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Practice: Use synthetic division to divide the polynomial by the given linear factor. Write any remainders as fractions of the divisor

1. $(3x^2 + 7x + 2) \div (x + 2)$

2. $(2x^2 + 7x - 15) \div (x + 5)$

3. $(7x^2 - 3x + 5) \div (x + 1)$

4. $(4x^2 + x + 1) \div (x - 2)$

5. $(3x^2 + 4x - x^4 - 2x^3 - 4) \div (x + 2)$

6. $(3x^2 - 4 + x^3) \div (x - 1)$

7. $(x^4 + 1) \div (x + 1)$

8. $(x^4 + 9) \div (x + 3)$

9. $(x^4 - 16) \div (x + 2)$

10. $\dfrac{x^6 + 4x^5 - 2x^3 + 7}{x + 1}$