

Chapter 4

Polynomial Functions

1. Graphing Polynomial Functions
2. **Adding, Subtracting, and Multiplying Polynomials**
3. Dividing Polynomials
4. Factoring Polynomials
5. Solving Polynomial Equations
6. The Fundamental Theorem of Algebra
7. Transformations of Polynomial Functions
8. Analyzing Graphs of Polynomial Functions
9. Modeling with Polynomial Functions



4.2 - Adding, Subtracting, and Multiplying Polynomials

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Simplify these polynomials

$$-4y^3 + 2y^2 - y + 2 + y^2 - 6y + 9$$

$$-4y^3 + 3y^2 - 7y + 11$$

$$(7z^2 - 4z) - (5z^2 - z + 3)$$

$$2z^2 - 3z - 3$$

4.2 - Adding, Subtracting, and Multiplying Polynomials

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Simplify these polynomials

$$1. 2x^3 - 7 + 5x^2 - x^3 + 3x - x^3 \qquad 5x^2 + 3x - 7$$

$$2. x^2y^2 - x^2 + 8x^2y^2 + 5xy^2 - 2x^2 \qquad -3x^2 + 9x^2y^2 + 5xy^2$$

4.2 - Adding, Subtracting, and Multiplying Polynomials

Find sum or difference

1. $(t^2 - 6t + 2) + (5t^2 - t - 8)$

2. $(8d - 3 + 9d^3) - (d^3 - 13d^2 - 4)$

4.2 - Adding, Subtracting, and Multiplying Polynomials

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Simplify these polynomials

1. $3(x^2 - 2x + 4) + 2(5x^2 - 7)$

$$13x^2 - 6x - 2$$

2. $4(3y^2 - 2y) + 3(y^2 + 5y - 1)$

$$15y^2 + 7y - 3$$

4.2 - Adding, Subtracting, and Multiplying Polynomials

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Exponents

$$(a^5)^3 = a^{15}$$

$$(3x)^4 = 81x^4$$

$$(x^m)^n = x^{mn}$$

$$(2x^2y^3)^5 = 32x^{10}y^{15}$$

1. $(2x^5)^4$

$$16x^{20}$$

2. $(-3x^k)^3$

$$-27x^{3k}$$

3. $(2x^3y(3x^2y^5))^3$

$$216x^{15}y^{18}$$

4.2 - Adding, Subtracting, and Multiplying Polynomials

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Multiply these polynomials

$$\begin{aligned} 1. (2x - 3)(3x + 6) \\ &= 6x^2 + 12x - 9x - 18 \\ &= 6x^2 + 3x - 18 \end{aligned}$$

$$\begin{aligned} 2. (3x + 2)(2x^2 - 3x + 1) \\ &= 6x^3 - 9x^2 + 3x + 4x^2 - 6x + 2 \\ &= 6x^3 - 5x^2 - 3x + 2 \end{aligned}$$

$$\begin{aligned} 3. (2x + 3y)^2 \\ &= 4x^2 + 12xy + 9y^2 \end{aligned}$$

4.2 - Adding, Subtracting, and Multiplying Polynomials

Special Product Patterns

Sum and Difference

$$(a + b)(a - b) = a^2 - b^2$$

Example

$$(x + 3)(x - 3) = x^2 - 9$$

Square of a Binomial

$$(a + b)^2 = a^2 + 2ab + b^2$$

$$(a - b)^2 = a^2 - 2ab + b^2$$

Example

$$(y + 4)^2 = y^2 + 8y + 16$$

$$(2t - 5)^2 = 4t^2 - 20t + 25$$

Cube of a Binomial

$$(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$$

$$(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3$$

Example

$$(z + 3)^3 = z^3 + 9z^2 + 27z + 27$$

$$(m - 2)^3 = m^3 - 6m^2 + 12m - 8$$

4.2 - Adding, Subtracting, and Multiplying Polynomials

Find the product

a. $(4x^2 + x - 5)(2x + 1)$

b. $(5a + 2)^2$

c. $(xy - 3)^3$

4.2 - Adding, Subtracting, and Multiplying Polynomials

Pascal's Triangle

	n	$(a + b)^n$	Binomial Expansion	Pascal's Triangle
0th row	0	$(a + b)^0 =$	1	1
1st row	1	$(a + b)^1 =$	$1a + 1b$	1 1
2nd row	2	$(a + b)^2 =$	$1a^2 + 2ab + 1b^2$	1 2 1
3rd row	3	$(a + b)^3 =$	$1a^3 + 3a^2b + 3ab^2 + 1b^3$	1 3 3 1
4th row	4	$(a + b)^4 =$	$1a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + 1b^4$	1 4 6 4 1
5th row	5	$(a + b)^5 =$	$1a^5 + 5a^4b + 10a^3b^2 + 10a^2b^3 + 5ab^4 + 1b^5$	1 5 10 10 5 1

Expand $(x - 2)^5$

4.2 - Adding, Subtracting, and Multiplying Polynomials

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Pascal's Triangle

$$\begin{array}{cccccccc} & & & & & & & 1 & & \longrightarrow & (x + y)^0 \\ & & & & & & & 1 & 1 & \longrightarrow & (x + y)^1 \\ & & & & & & 1 & 2 & 1 & \longrightarrow & (x + y)^2 \\ & & & & & 1 & 3 & 3 & 1 & \longrightarrow & (x + y)^3 \\ & & 1 & 4 & 6 & 4 & 1 & & & \longrightarrow & (x + y)^4 \\ 1 & 5 & 10 & 10 & 5 & 1 & & & & \longrightarrow & (x + y)^5 \end{array}$$

4.2 - Adding, Subtracting, and Multiplying Polynomials

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Pascal's Triangle

$$\begin{array}{cccccccc} & & & & & & & 1 & & \longrightarrow & (x + y)^0 \\ & & & & & & & 1 & 1 & \longrightarrow & (x + y)^1 \\ & & & & & & 1 & 2 & 1 & \longrightarrow & (x + y)^2 \\ & & & & & 1 & 3 & 3 & 1 & \longrightarrow & (x + y)^3 \\ & & 1 & 4 & 6 & 4 & 1 & & & \longrightarrow & (x + y)^4 \\ & 1 & 5 & 10 & 10 & 5 & 1 & & & \longrightarrow & (x + y)^5 \end{array}$$

What is $(a + b)^6$?

What is $(a - b)^5$?

4.2 - Adding, Subtracting, and Multiplying Polynomials

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Practice - Pascal's Triangle

						1											
							1		1								
								1	2	1							
									1	3	3	1					
										1	4	6	4	1			
												1	5	10	10	5	1

1. $(x - 3)^5$

$$x^5 - 15x^4 + 90x^3 - 270x^2 + 405x - 243$$

2. $(a + 2b)^6$

$$a^6 + 12a^5b + 60a^4b^2 + 160a^3b^3 + 240a^2b^4 + 192ab^5 + 64b^6$$

4.2 - Adding, Subtracting, and Multiplying Polynomials

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Factorials

$$12! = 12 \cdot 11 \cdot 10 \cdot 9 \cdot 8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 479,001,600$$

$$6! = 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 720$$

$$\frac{12!}{6!} =$$

4.2 - Adding, Subtracting, and Multiplying Polynomials

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Possible combinations of letters A, B, and C?

$$3! = 3 \cdot 2 \cdot 1 = 6$$

Possible combinations of 12 people sitting in 6 chairs?

$$\frac{12!}{6! \cdot 6!} = {}_{12}C_6$$

4.2 - Adding, Subtracting, and Multiplying Polynomials

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What is the coefficient of $x^{21}y^5$?

$${}_{26}C_{21} = {}_{26}C_5 = \frac{26!}{21! \cdot 5!}$$

1. Coefficient of x^9y^{22} ?

$${}_{31}C_9 = \frac{31!}{9! \cdot 22!}$$

2. Coefficient of $x^{12}y^9$?

$${}_{21}C_{12} = \frac{21!}{12! \cdot 9!}$$

3. Coefficient of x^3 in expansion of $(3x + 2)^5$?

$${}_5C_3(3x)^3(2)^2 = \frac{5!}{3! \cdot 2!}(27x^3)(4) = 1080x^3$$

