

2.3 Polynomial Functions

- Objectives: 1) I can find the **zeros** of a polynomial function by **factoring**.
 2) I can use a **graph** to locate **zeros**.
 3) I can describe the **end behavior** of a function using **limits**.
 4) I can determine the **multiplicity** of a zero.
 5) I can **sketch the graph** of a polynomial function by finding zeros, multiplicity, and end behavior.

Zeros

A zero is the value for "x" that makes $f(x) = 0$.

Remember $f(x) = y$ so **zeros** are where the graph **touches the x-axis**.

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Finding Zeros

Algebraically: 1) **Factoring!!**

$f(x) = (x-1)(x+2)(x+3)$
 $x-1=0 \quad x+2=0 \quad x+3=0$
 $x=1 \quad x=-2 \quad x=-3$

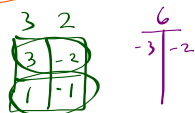
$h(x) = 3x^3 - 5x^2 + 2x$

$h(x) = x(3x^2 - 5x + 2)$

$h(x) = x(3x-2)(x-1)$

$0 = x(3x-2)(x-1)$

$x=0 \quad 3x-2=0 \quad x-1=0$
 $x = \frac{2}{3} \quad x=1$

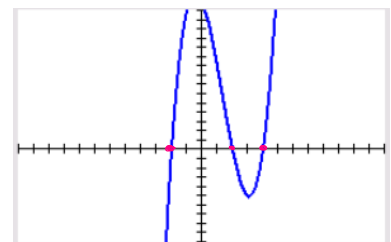


$3x^2 - 3x - 2x + 2$
 $3x(x-1) - 2(x-1)$
 $(x-1)(3x-2)$

2) **Graphically**

State the zeros of the function.

$x = -2, 2, 4$

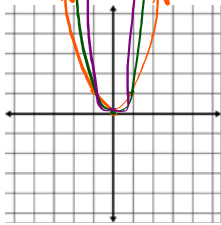


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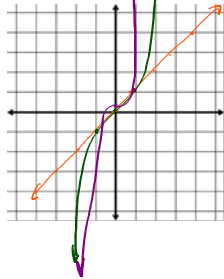
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Graphing Higher Order Polynomials

$f(x) = x^2, g(x) = x^4, h(x) = x^6$



$f(x) = x, g(x) = x^3, h(x) = x^5$



End Behavior

Limit notation:

$$\lim_{x \rightarrow -\infty} f(x) = \quad \quad \quad \lim_{x \rightarrow \infty} f(x) =$$

"As x approaches infinity/negative infinity, f(x), or y, approaches _____."

Look at graphs on previous slide.

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What is the degree of the following polynomials?

$f(x) = -89x^6 + 3x^5 + 2x^3 - 7x + 2$ *Deg 6*

$g(x) = x^2(x-3)(x+5)^3(x+1)^2$ *Deg 8*

$h(x) = (x-5)^2(x+2)^3$ *Deg 5*

$k(x) = \frac{5}{3}x^5 + 3x^3 - 7x^2 + x - 12$ *Deg 5*

★The degree determines end behavior★

Odd degree: **positive** **negative**

$\lim_{x \rightarrow -\infty} f(x) = -\infty$ $\lim_{x \rightarrow -\infty} f(x) = \infty$

$\lim_{x \rightarrow \infty} f(x) = \infty$ $\lim_{x \rightarrow \infty} f(x) = -\infty$

Even degree: **positive** **negative**

$\lim_{x \rightarrow -\infty} f(x) = \infty$ $\lim_{x \rightarrow -\infty} f(x) = -\infty$

$\lim_{x \rightarrow \infty} f(x) = \infty$ $\lim_{x \rightarrow \infty} f(x) = -\infty$

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Multiplicity

The power of the factor determines the nature of the intersection at the point $x = a$.
(This is referred to as the **multiplicity**.)

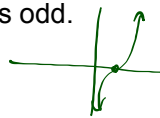
Straight intersection: (crosses straight...ly)
 $(x - a)^1$ The power of the zero is 1.



Tangent intersection : (bounces)
 $(x - a)^{\text{even}}$ The power of the zero is even.



Inflection intersection: (crosses squigggggllly)
 $(x - a)^{\text{odd}}$ The power of the zero is odd.



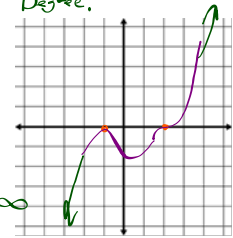
Find the ¹zeros, the ²multiplicity, end ³behavior and ⁴graph the following ⁵Degree.

$$f(x) = (x-2)^3(x+1)^2$$

$$x=2 \text{ mult } 3$$

$$x=-1 \text{ mult } 2$$

$$\lim_{x \rightarrow -\infty} f(x) = -\infty \quad \lim_{x \rightarrow \infty} f(x) = \infty$$

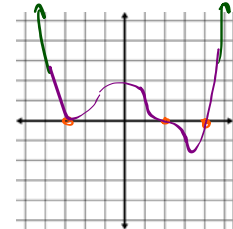


$$f(x) = (x+3)^2(x-2)^3(x-4)$$

$$x=-3 \text{ mult } 2$$

$$x=2 \text{ mult } 3$$

$$x=4 \text{ mult } 1$$

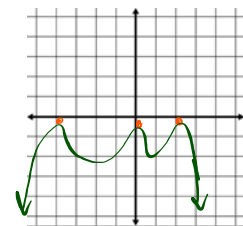


$$f(x) = -x^2(x-2)^2(x+4)^2$$

$$x=0 \text{ mult } 2$$

$$x=2 \text{ mult } 2$$

$$x=-4 \text{ mult } 2$$



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Find the zeros, the multiplicity, end behavior and graph the following

$$f(x) = x^3 - 7x^2 - 18x$$

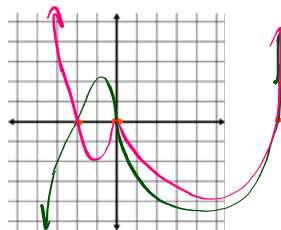
$$= x(x^2 - 7x - 18)$$

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

$$x=0$$

$$x=9$$

$$x=-2$$



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