**Math 3 Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Unit 3, Lesson 4: Finding All Roots of Polynomials**

The degree of the polynomial tells us how many roots/zeros/solutions a polynomial has. Those roots can be real, imaginary, or a combination of both. Yesterday we discussed how imaginary (and irrational) roots alway travel in pairs (conjugates of each other).

This means we automatically know this:

|  |  |  |
| --- | --- | --- |
| **Degree** | **Roots** | **Possible Combinations** |
| 1 | 1 | 1 Real Root  |
| 2  | 2 | 2 Real Roots, **or** 2 Imaginary Roots  |
| 3 | 3 | 3 Real Roots, **or** 1 Real and 2 Imaginary Roots |
| 4 | 4 | 4 Real Roots, **or** 2 Real and 2 Imaginary Roots, **or** 4 Imaginary Roots  |
| etc |   | etc! |

And so: When the degree is odd (1, 3, 5, etc) there is **at least one real root** ... guaranteed!

Remember, real roots are locations where the graph crosses (or touches depending on multiplicity) the x-axis.

**We will now put everything we have discussed about polynomials together to find ALL roots of a polynomial.**

**Find all roots of the given polynomials.**

1. ****
* **Step 1: How many roots does the polynomial have? (What is the degree?) \_\_\_\_\_\_\_**
* **Step 2: How many roots are real? \_\_\_\_\_\_\_\_\_\_**
	+ **(Graph it to see how many times graph crosses or touches x-axis – Remember multiplicity rules!)**
* **Step 3: Find all real roots. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
	+ **Let Y2=0 and find intersection(s) with the x-axis for all real roots that cross x-axis.**
* **Step 4 (if needed): Use real root(s) to depress polynomial using synthetic division.**
* **Step 5 (if needed): Solve remaining quadratic equation to find remaining roots (usually by using quadratic formula)**
1. ****
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	* **Step 2: How many roots are real? \_\_\_\_\_\_\_\_\_\_**
* **(Graph it to see how many times graph crosses or touches x-axis – Remember multiplicity rules!)**
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	* **Step 1: How many roots does the polynomial have? (What is the degree?) \_\_\_\_\_\_\_**
	* **Step 2: How many roots are real numbers? \_\_\_\_\_\_\_\_\_\_**
* **(Graph it to see how many times graph crosses or touches x-axis – Remember multiplicity rules!)**
	+ **Step 3: Find all real roots. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
		- **Let Y2=0 and find intersection(s) with the x-axis for all real roots that cross x-axis.**
	+ **Step 4 (if needed): Use real root(s) to depress polynomial using synthetic division.**
	+ **Step 5 (if needed): Solve remaining quadratic equation to find remaining roots (usually by using quadratic formula)**
1. ** Degree = \_\_\_\_\_\_\_\_\_; # of roots: \_\_\_\_\_\_\_; # of real roots: \_\_\_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. ** Degree = \_\_\_\_\_\_\_\_\_; # of roots: \_\_\_\_\_\_\_; # of real roots: \_\_\_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Find all roots of the function using the given root.**

1. ** ;  is a root Degree = \_\_\_\_; # of roots: \_\_\_\_; # of real roots: \_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Practice! Show all work on a separate sheet. No work = No credit!**

**1.** *f*(*x*) = *x*3 − 9*x*2 + 27*x −* 27 **Degree = \_\_\_\_; # of roots: \_\_\_\_; # of real roots: \_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**2.** *y* = 2*x*3 − 8*x*2 + 18*x −* 72 **Degree = \_\_\_\_; # of roots: \_\_\_\_; # of real roots: \_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**3.** *y* = *x*3 − 10*x −* 12 **Degree = \_\_\_\_; # of roots: \_\_\_\_; # of real roots: \_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**4.** *y* = *x*3 − 4*x*2 + 8  **Degree = \_\_\_\_; # of roots: \_\_\_\_; # of real roots: \_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**5.** *f*(*x*) = 2*x*3 + *x −* 3 **Degree = \_\_\_\_; # of roots: \_\_\_\_; # of real roots: \_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**6.** *y* = *x*3 − 2*x*2 − 11*x +* 12 **Degree = \_\_\_\_; # of roots: \_\_\_\_; # of real roots: \_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**7.** *g*(*x*) = *x*3 + 4*x*2 + 7*x +* 28 **Degree = \_\_\_\_; # of roots: \_\_\_\_; # of real roots: \_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**8.** *f*(*x*) = *x*3 + 3*x*2 + 6*x +* 4 **Degree = \_\_\_\_; # of roots: \_\_\_\_; # of real roots: \_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**9.** *g*(*x*) = *x*4 − 5*x*2 − 36 **Degree = \_\_\_\_; # of roots: \_\_\_\_; # of real roots: \_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**10.** *y* = *x*4 − 7*x*2 + 12 **Degree = \_\_\_\_; # of roots: \_\_\_\_; # of real roots: \_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**11.** *y* = 9*x*4 + 5*x*2 − 4  **Degree = \_\_\_\_; # of roots: \_\_\_\_; # of real roots: \_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**12.** *y* = 4*x*4 − 11*x*2 − 3 **Degree = \_\_\_\_; # of roots: \_\_\_\_; # of real roots: \_\_\_\_\_**

**List of all roots: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**