**The Factor-Root Theorem**

### Preliminaries
- Polynomials
- Factoring
- Function Notation

### Objectives
- Definition of root
- Factor polynomials

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**Example 1**

Let \( p(x) \) be a polynomial function, then \( r \) is a root of \( p \) if \( p(r) = 0 \)

Example: Is \( x = 3 \) a root of \( p(x) = x^2 - 8x + 15 \)?

Plug in the value to find \( p(3) = 3^2 - 8(3) + 15 = 0 \)

Since \( p(3) = 0 \), then \( x = 3 \) is a root of \( p(x) \)

### Example 2

Factor \( p(x) = x^3 - x^2 - 9x - 12 \)

\( x = 4 \) is a root since \( p(4) = 4^3 - 4^2 - 9(4) - 12 = 0 \), therefore \( x - 4 \) is a factor.

\[ p(x) = x^3 - x^2 - 9x - 12 = (x - 4)(x^2 + 3x + 3) \]

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**Example 3**

Let \( p(x) = x^3 + 5x^2 + 2x - 8 \).

Check to see which of the following are roots.
\(-4, -2, -1, 1, 2, 4\).

Factor \( p(x) \).

The three roots are \(-4, -2 \) and \( 1 \), therefore
\[ p(x) = (x + 4)(x + 2)(x - 1) \]

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**Recap**

**Definition of Root**

Let \( p(x) \) be a polynomial function, then \( r \) is a root of \( p \) if \( p(r) = 0 \)

**Factor-Root Theorem**

- **Part I** - If \( p(x) \) is a polynomial and \( (x - r) \) is a factor of \( p(x) \), then \( r \) is a root.
- **Part II** - If \( r \) is a root of \( p(x) \), then \( (x - r) \) is a factor of \( p(x) \).