When solving for the zeros of a function, it helps if we can break the function down into factors. Synthetic division will be useful to us.

**Factor Theorem**
A polynomial \( f(x) \) has a factor \((x-k)\) if and only if \( f(k) = 0 \).

**Remainder Theorem**
If a polynomial \( f(x) \) is divided by \((x-k)\), then the remainder \( r = f(k) \).

Long division is ALWAYS useful for division of polynomials.

Synthetic division is only useful when dividing by \((x-k)\) where \( k \in \mathbb{R} \).

**Ex 1**: Use long division to divide \((4x^3 + 10x^2 - 2x - 5)\) by \((2x^2 - 1)\).
Ex 2: Divide \((x^3 + 4x^2 - 3x + 2)\) by \((x-3)\) in two ways.

- Long division
- Synthetic division

Ex 3: Use synthetic division to compute this quotient.

\[(5x^3 + 6x + 8) \div (x + 2)\]

Write the result in the form \(f(x) = (x-k)(g(x)) + r(x)\)

Ex 4: Use the remainder theorem and synthetic division to show that \((x+3)\)
is a factor of this function.

\[f(x) = 3x^3 + 5x^2 - 3x + 27\]
Ex 5: Use division to show that 2/3 is a solution of \(48x^3 - 80x^2 + 41x - 6 = 0\). Use the result to factor the polynomial completely and find all solutions.