

# CS / MATH 4334 : Numerical Analysis

## Homework Assignment 1

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### Theoretical Problems

1. Show how to evaluate the polynomial  $p(x) = 2x^{25} + 7x^{15} - x^{10} + 4x^5 - 1$  using as few arithmetic operations as possible.

To begin to solve this problem, we must first break down the polynomial  $p(x)$ . I will start by storing some of the possible polynomial values ahead of time to conserve arithmetic operations.

$x = x$	- identity	(0+0 = 0 multiplications)
$x^2 = x * x$	- 1 multiplication	(0+1 = 1 multiplications)
$x^4 = x^2 * x^2$	- 1 multiplication	(1+1 = 2 multiplications)
$x^5 = x^4 * x$	- 1 multiplication	(2+1 = 3 multiplications)

In total, storing values until we have stored an  $x^5$  will net us a total of 3 multiplications. Next, we will apply a Horner's expansion to the function  $p(x)$ , given by:

$$\begin{aligned}p(x) &= 2x^{25} + 7x^{15} - x^{10} + 4x^5 - 1 \\p(x) &= x^5 * (2x^{20} + 7x^{10} - x^5 + 4) - 1 \\p(x) &= x^5 * (x^5 * (2x^{15} + 7x^5 - 1) + 4) - 1 \\p(x) &= x^5 * (x^5 * (x^5 * (2x^{10} + 7) - 1) + 4) - 1 \\p(x) &= x^5 * (x^5 * (x^5 * (x^5 * (2x^5 + 0) + 7) - 1) + 4) - 1 \\p(x) &= x^5 * (x^5 * (x^5 * (x^5 * (x^5 * (2) + 0) + 7) - 1) + 4) - 1\end{aligned}$$

Expanding  $p(x)$  with Horner's method and storing the calculations prior to the functions evaluation nets us a total of 8 multiplications and 5 additions or subtractions.

























