Mathematica Assignment A

Review of Algebra and Derivatives

At the simplest level, Mathematica performs the calculations of a standard calculator. To evaluate a command, hold the [Shift] key and press [Return]. Some basic Mathematica commands appear below:

\[
x y \quad \text{x times y (note the space)}
\]
\[
x*y \quad \text{also x times y}
\]
\[
xy \quad \text{variable with name xy}
\]
\[
5x \quad \text{5 times x}
\]
\[
5 \quad \text{also 5 times x}
\]
\[
5*x \quad \text{also 5 times x}
\]
\[
x^2 \quad x^2
\]
\[
x^{(2y)} \quad x \text{ to the power 2y}
\]
\[
x^y \quad x^2 \text{ times y}
\]
\[
x/y \quad x \text{ divided by y}
\]
\[
\text{Pi} \quad \pi
\]
\[
E \quad e
\]
\[
\text{Infinity} \quad \infty
\]
\[
\text{Cos}[\text{Pi}/6] \quad \cos\left(\frac{\pi}{6}\right) \text{ (note the square brackets and capital C)}
\]

Mathematica uses parentheses ( ) for grouping. Square [ ] and curly { } brackets have other purposes, and you may receive an error message or an unexpected result if you use them improperly. Mathematica is also case-sensitive, i.e., \text{Pi} is not the same as \text{pi}. Improper use of capital letters can also yield error messages or unexpected results.

Open a new Mathematica notebook, type the line below, then hold the [Shift] key while you press [Return]:

\[(3+4)^2-2(3+1)^4\]

If you didn't get an output of -463 from Mathematica, then check your work and try again.

Mathematica can also be used to expand, factor, and simplify polynomial and rational expressions. These commands can be used as follows:

- \text{Expand[expression] multiplies out products and powers, writing the result as a sum of terms.}
- \text{Factor[expression] writes the expression as a minimal product of terms.}
- \text{Simplify[expression] finds the form of the expression with the smallest number of terms.}

Note the use of square brackets with commands.

Type and evaluate each of the following:

- \text{Expand[(x+5y+10)^4]}
- \text{Factor[x^10-1]}
- \text{Simplify[x^5+2x+1]}

Mathematica can find exact solutions to algebraic equations of degree less than or equal to 5. To enter an equation in Mathematica, you must use a double equal sign. For example, the equation \(x^2 + 5x + 6 = 0\) is written \(x^2 + 5x + 6 == 0\). Mathematica can
solve this equation for \( x \) with the command \( \text{Solve}[x^2+5x+6=0, x] \).

For equations of degree greater than 5, \textit{Mathematica} may or may not be able to find an exact solution. It can, however, always give you a numerical approximation that is correct to as many digits as you specify. To obtain a numerical approximation, use the command \texttt{N} as follows:

\( \text{N[%]} \) gives the numerical value of the last output generated (correct to a default number of digits).
\( \text{N[%, } m \text{]} \) gives the numerical value of the last output generated correct to \( m \) digits.

Evaluate the following examples:

\( \text{Solve}[x^2+2x-7==0, x] \)
\( \text{N[]} \)
\( \text{Pi} \)
\( \text{N[%,} 25 \text{]} \)

\textit{Mathematica} can also do calculus. The command \texttt{D[function, } x \text{]} gives the derivative of the function with respect to \( x \). To see how this command works, evaluate the following:

\( \text{D}[x^7-2x^5+4x^3-5x, x] \)
\( \text{D}[5\sin(x)-6\cos(x), x] \)

Use the command \texttt{Plot[function, } \{x, a, b\} \text{]} to create a graph of the function with variable \( x \) from \( a \) to \( b \). Try the following:

\( \text{Plot}[x^7-2x^5+4x^3-5x, \{x, -2, 2\}] \)
\( \text{Plot}[5\sin(x)-6\cos(x), \{x, -3\pi, 3\pi\}] \)

When doing \textit{Mathematica} assignments, you should save your work frequently on the desktop so that you don't lose it if something unexpected happens.