Mathematica Assignment 1

Introduction to *Mathematica*

Create a *Mathematica* notebook that solves the following problems. Be sure to clearly label each section of your notebook based on which problem you are solving. You can change an input cell to a text cell by selection the Format tab from the top menu and choosing Text from the Style option. Email a copy of your finalized notebook to `byoung@wyomingseminary.org` with the subject "Computer Project 1."

Part A

For the functions given below, use *Mathematica* to compute the following items for the functions given below. If *Mathematica* returns a complicated form for a particular zero, a numerical approximation is acceptable (give at least 6 decimal places).

a) All real zeros

b) The first derivative and its real zeros

c) The second derivative and its real zeros

d) A plot of the function with viewing area large enough to show all zeros, critical points, and points of inflection

1) $f(x) = x^4 + 2x^3 - 17x^2 - 4x + 30$
2) $g(x) = e^{x^3-3x^2+2x} - 1$

Part B

Use *Mathematica* to give a graph of the regions described below. Compute the total area of the region exactly and give a numerical approximation of the area (accurate to at least 6 decimal places) using *Mathematica*.

a) The finite region contained between the curves

$$y = \frac{x^2}{(x^2+16)^{3/2}} \text{ and } y = \frac{9}{125}.$$

b) The finite region contained between the curves

$$y = e^{-x^2} \text{ and } y = x^2.$$

Some Helpful Commands

Instead of a separate help file, I will describe some of the basic commands you will need below. For each command, you should look at the Wolfram Documentation which is accessible from the Help tab. Each of the basic commands below has MANY options that are explained in detail in the documentation.

- **Part A:**

  1) To define a function in *Mathematica*, you must use the following syntax.

     ```
     f[args_] := function definition
     ```

     Each argument that the function uses **must be** followed by an underscore. Also note that function definition uses colon + equals (the "walrus operator"). The following examples show functions of 1, 2, and 3 variables, respectively.

     ```
     f[x_] := 2x^3 - 3x^2 + 4x - 7
     f[x_, y_] := 3*Sin[2x - 3y^2]
     f[x_, y_, z_] := x*Exp[2xy - z^3]
     ```

  2) The `Solve` command has basic syntax

     `Solve[`*expr, vars, dom*`]`.

     For example, `Solve[2x^2-3x+2==0,x,Reals]` will find all real solutions to $2x^2 - 3x + 2 = 0$. The *dom* argument is optional (and defaults to complex numbers).

  3) The `D` command is *Mathematica*'s all–purpose differentiation command. The two most common syntaxes are

     `D[`*f, x*`]`,
     `D[`*f*, $\{x, n\}$`]`.

     So, `D[Sin[`x`] , `x`]` will compute the first derivative of sine. `D[Sin[`x`] , `$\{x, 30\}$`]` will compute the 30-th derivative of sine.

4) The `Plot` command has the basic syntax

$$\texttt{Plot[}f\texttt{, }\{x, x_{\min}, x_{\max}\}\texttt{].}$$

For instance `Plot[`x`^3, `$\{x, -5, 2\}$`]` will generate the graph $y = x^3$ over the range $-5 \leq x \leq 2$. `Plot` has a LARGE number of options that allow you to customize the graph. Typical add–ons are axes labels, plot labels, and legends. See the documentation for details.

- **Part B:**

1) The `Integrate` command has the following basic syntaxes:

$$\texttt{Integrate[}f\texttt{, }x\texttt{]} \text{ (for indefinite integrals),}$$
$$\texttt{Integrate[}f\texttt{, }\{x, x_{\min}, x_{\max}\}\texttt{]} \text{ (for definite integrals).}$$

Note that *Mathematica* WILL NOT add an arbitrary constant to an indefinite integral (i.e. no "$+C$"). For definite integrals, the basic syntax is precisely the same as for `Plot`.

2) The `N` command is *Mathematica*'s general purpose numeric approximation tool. The two basic syntaxes are

$$\texttt{N[}\mathit{expr}\texttt{]},$$
$$\texttt{N[}\mathit{expr}\texttt{,}n\texttt{]}.$$

So, `N[ArcTan[3]/Pi]` will give you a decimal approximation to the number $\arctan(3)/\pi$ to a default number of digits. The command `N[ArcTan[3]/Pi,100]` would give you 100 total digits in the expansion of $\arctan(3)/\pi$.