MathCAD – Solving Equations

Iterative solutions to equations and systems of equations: We have learned how to solve systems of simultaneous equations using matrix methods. Another way to solve such equations in MathCAD is to use iterative solve blocks. These blocks are bounded by the keywords Given and Find. The equations we wish to solve are embedded in a block between these key words. Before setting up this block, we must first provide an initial guess for the value of each variable in the solve block. Different initial guesses may lead to quite different solutions, or may yield the same solution.

Example 1: Solve the equation $4y^3 + 8y - 13 = 0$ using the Iterative Solve Block technique.

Use quickplots to select a value for your initial guess. You should play with the values on each axis to get the plot into a form from which the result can be read (estimated). For single variable problems like this example, plotting is especially useful.

$$y := -1, 0..2$$

Above, for what $y$-value does the equation in question equal zero? That is your initial guess for the iterative block.

$$y := 1$$

Given

$$4y^3 + 8y - 13 = 0$$

(this equal sign is made with Ctrl = it is also the equal sign available in the Boolean toolbar)

$$y := \text{Find}(y)$$

$$y = 1.049$$

How can you be sure that this is the (a) true solution?
Always check your solutions by inserting the results back into the original equation(s). The extra effort is minimal and very worthwhile!

\[ y = 1.049 \]

\[ 4y^3 + 8y - 13 = 1.89 \times 10^{-7} \quad \text{Close enough to Zero!!} \]

**Example 2:** For a system of equations, all equations must appear in the block between the keywords “Given” and “Find.” These equations are written using the symbolic equality sign (read about this and other equal signs in Chapter 2 of the ENGR 162 book). Initial guesses must be made for the values of each variable. Multivariable plots help you visualize the problem and make reasonable initial guesses for the values. Often, we just set our guesses to be “0.”

\[
\begin{align*}
  x & := 0 \\
  y & := 0 \\
  z & := 0
\end{align*}
\]

**ENGR162 Lab Assignment #10:**

Solve problems A through D below using the Iterative Solve Block method illustrated above. **Verify all answers, without exception.**

A. (15 points) Once more solve example 2 above by finding a solution vector \( x, y \) and \( z \). Try multiple sets of initial guesses. Do you get other solutions? Then, check that all results found are in fact solutions to the system of equations.

B. (19 points) Find the roots of \( 6z^3 - 20z + 4 = 0 \). How many roots do you expect? Use quickplots to narrow down your search for solutions. Verify your results.

C. (22 points) Solve for \( x \) given that \( x^3 - x^2 + x = 2 \). Again, use quickplots to estimate initial guess. How many roots should there be? How many did you find? (Hint: Use both real and imaginary numbers for your initial guesses.)

D. (28 points) Given that \( \tan(x) = 2.5 x^2 \), solve for all roots in the range \(-2 < x < 2\). Use a quickplot to determine how many roots exist in this range, and for your guestimates. (Hint: Plot two equations and find where they equal [intersect]). Verify your results (always!).

E. (16 points) From the ENGR 162 textbook, solve problem 4 on page 210. Double-check that you haven’t forgotten anything!