ENGR 162 - Fall 2004

Lab WS 11: Symbolic Math using MathCAD

Required Reading: ENGR 162 textbook Chapters 6 & 7

Calculus and MathCAD

In engineering and applied science, we often need to manipulate symbols and equations rather than numbers. MathCAD allows us to perform manipulations on equations employing either the Symbolics Menu or the Symbolics Keyword Toolbar. The first is accessed from the menu bar; the second from the mortarboard on the Math Toolbar. Activate both the Symbolics Keyboard Toolbar and the Calculus Toolbar, then review the commands in them available to you.

Symbolics Menu: Explore the commands contained in the Symbolics Menu. Notice that some commands lead to a second level of commands. Also note the Evaluation Style option; it allows you to indicate where to display the results of an operation.

Symbolics Keyword Toolbar: Live symbolic operators are available (i.e. MathCAD automatically recalculates the value of an expression when the information used in the calculation changes). Note that computations in the Symbolics Menu are NOT live.

Solving Equations: Enter the equation, select Variable-Solve from the Symbolics Menu or Solve from the Symbolics Toolbar, and fill the variable into the placeholder.

Example 1: Try these equations: \( x^2 - 7x +12 = 0 \) and \( X^2 + 12 XY + 36Y^2 = 0 \)

\[
x^2 - 7x + 12 \text{ solve,} \ x \rightarrow \begin{pmatrix} 3 \\ 4 \end{pmatrix}
\]

\[
X^2 + 12X\cdot Y + 36Y^2 \text{ solve,} \ Y \rightarrow \begin{pmatrix} -1 \cdot X \\ 6 \\ -1 \cdot X \\ 6 \end{pmatrix}
\]

Notice that when an equation equals zero, the second part of the equation is omitted when it is entered into MathCAD.

Example 2: If the equation is \( x^2 + 8x = -16 \), then type in

\[
x^2 + 8x + 16 \text{ solve,} \ x \rightarrow \begin{pmatrix} -4 \\ -4 \end{pmatrix}
\]
Manipulating Equations: The basic equation manipulation methods you learned in Algebra are available in MathCAD. Enter an equation, select the desired manipulation from the menu or bar and fill in a variable name in the placeholder, if needed. Some examples of equation manipulations are: Factor, Expand, Simplify, Collect functions, etc..

In each practice problem, try to anticipate the result before MathCAD shows it to you.

Example 3: Factor $X^3 - 3X^2 - 22X + 24$

$$X^3 - 3X^2 - 22X + 24 \quad \text{factor} \rightarrow (x-1)(x+4)(x-6)$$

(Note: To use factor this way, delete the x placeholder! The textbook is wrong!)

Example 4: Expand $(x-4)(x+5)$

$$(x-4)(x+5) \quad \text{expand} \rightarrow x^2+x-20$$

Example 5: Simplify $\frac{x}{x^2} + \frac{1}{x^3}$

$$\frac{x}{x^2} + \frac{1}{x^3} \quad \text{simplify} \rightarrow \frac{x^2 + 1}{x^3}$$

Example 6: Expand using Partial-Fraction:

$$\frac{(4 \cdot x + 79)}{(x^2 + x - 30)}$$

$$\frac{(4 \cdot x + 79)}{(x^2 + x - 30)} \quad \text{convert, parfrac, x} \quad \frac{9}{(x - 5)} - \frac{5}{(x + 6)}$$
ENGR162 Lab Assignment #11: Solve exercises A through K below:

A. (11 points) Given the set of equations \( x + y^2 = 4 \), \( x + 3y = z \), \( xy = 3 \), solve for \( x \), \( y \), and \( z \) using 3 different sets of initial guesses. How many solutions do you find?

B. (7 points) Solve the following equation set using the Iterative Solve Block (review Lab 10).
\[
\begin{align*}
x + 2y + 3z &= 3 \\
2x - 4y - 6z &= 9 \\
4x + 8y - 9z &= 27
\end{align*}
\]

C. (6 points) Solve Exercise B using the matrix method to see if you get the same results.

D. (12 points) Solve the following equations (similar to practice examples 1 and 2):
\[
\begin{align*}
i) \quad &x^2 + 4x - 12 \\
ii) \quad &x^3 + 8 \\
iii) \quad &\frac{(x+4)}{(x^2 + 6x - 2)} \\
iv) \quad &6x^2 - 4ax - 9bx + 6ab \quad \text{(Solve for } x) \\
\end{align*}
\]

E. (6 points) Factor the following expressions:
\[
\begin{align*}
i) \quad &x^2 - 16 \\
ii) \quad &x^2 - 8x + 16
\end{align*}
\]

F) (8 points) Expand the following:
\[
\begin{align*}
i) \quad &(2x + 7y)^3 \\
ii) \quad &(y + 1)(y - 2)(y + 3)
\end{align*}
\]

G) (7 points) Simplify the following:
\[
\begin{align*}
i) \quad &\frac{1}{x^2} + \frac{2}{x^3} \\
ii) \quad \frac{x}{(x - 3)} + \frac{7}{(x - 6)} - \frac{5}{(x - 3)}
\end{align*}
\]

H. (8 points) Collect the expression \( x^3 + \left( y + \frac{3}{x} \right) y^2 - x + y^2 \cdot x^2 \) in terms of powers of both \( x \) & \( y \)

I. (6 points) Obtain the partial fraction expansion of:
\[
\frac{x^2 - 8x + 6}{(x - 8)^3}
\]

J. (10 points) ENGR 162 Textbook, page 179, problem 1.