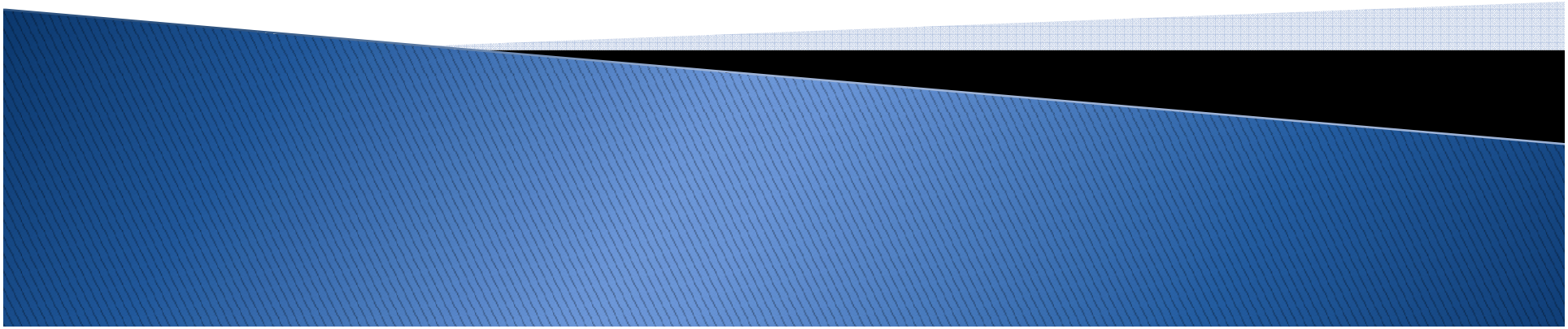
CGN 2420
Introduction to Mathcad

Instructor: Professor Cora Martinez, PhD
Department of Civil and Environmental Engineering
Florida International University



Objectives

- Understand how Mathcad can assist the engineering design process.
- Familiarize with the Mathcad interface.
- Know how Mathcad handles equations and units.
- Learn how to enter format text regions on a Mathcad worksheet.
- See how Mathcad can help you present your results.

Mathcad

- Mathcad is an equation-solving software package that has a wide range of applicability to engineering problems.
- It has the ability to display equations the same way you would write them on paper.
- A Mathcad worksheet could include:

Definitions	Variables
Equations	Text
Data	Graphs

Mathcad

- Mathcad advantages:
  - Equations displayed in highly readable form.
  - Ability to work with units, access to reference tables.
  - Symbolic math capability.
  - Iterative solution capability, problem solver.
  - Extensive function library.
  - Programming capability.

Mathcad

As a design tool:

- Mathcad worksheet is a collection of variable definitions, equations, text regions, and graphs displayed on the screen in the same fashion you would write them on a paper.
- Big difference: *automatic recalculation*.
- Advantages:
  - Calculations in a orderly way.
  - Adding comments to your work.
  - Using units on your variables.

Mathcad

As a mathematical problem solver:

- Mathcad has the ability to solve problems numerically or symbolically.
- It has a large collection of built-in functions for:
  - Trigonometric calculations.
  - Statistical applications.
  - Data analysis.
  - Matrix operations.
  - Calculus.
  - Iterative procedures.

Mathcad

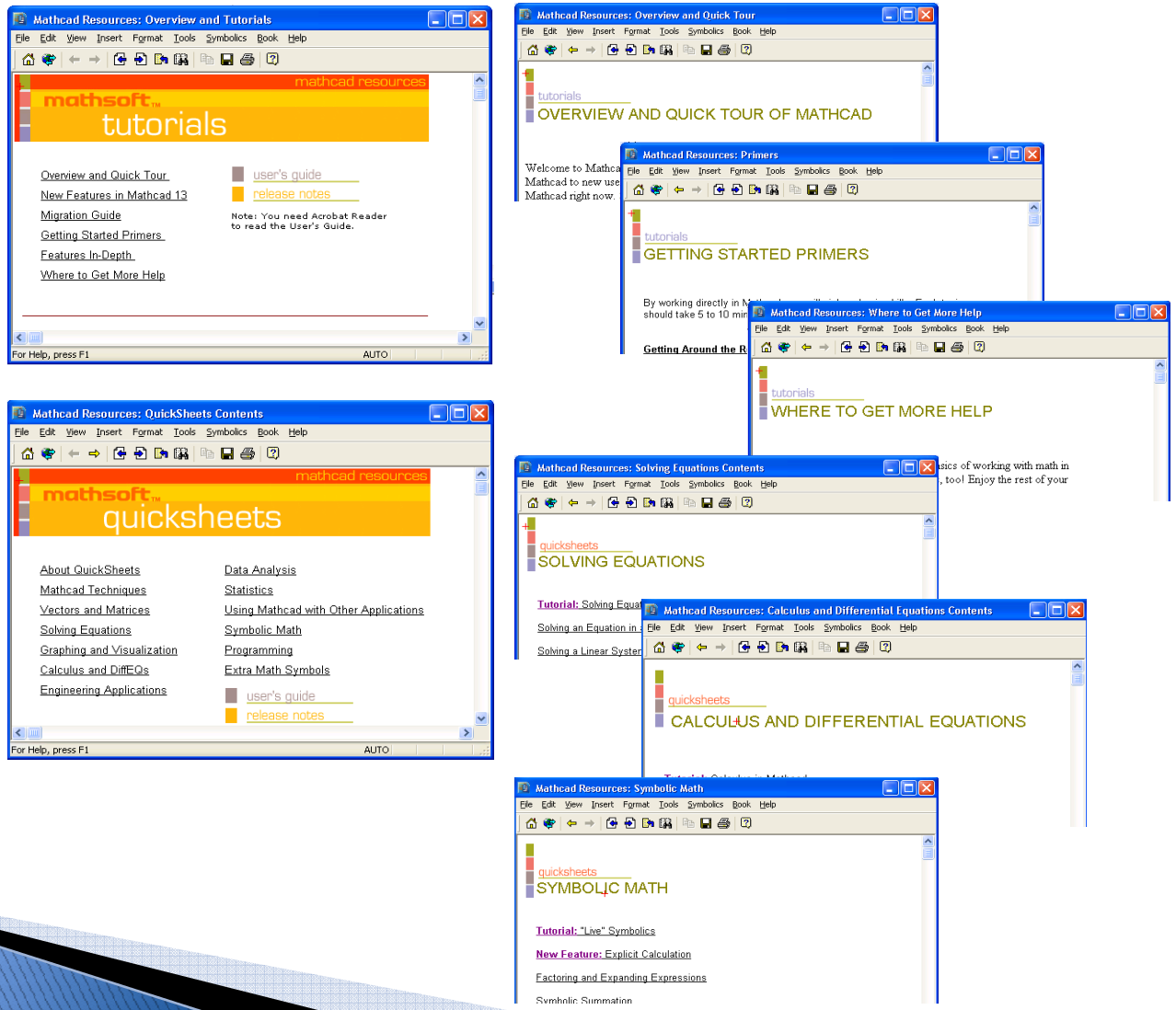
As a unit converter:

- It allows you to build units into most equations.

For presenting results:

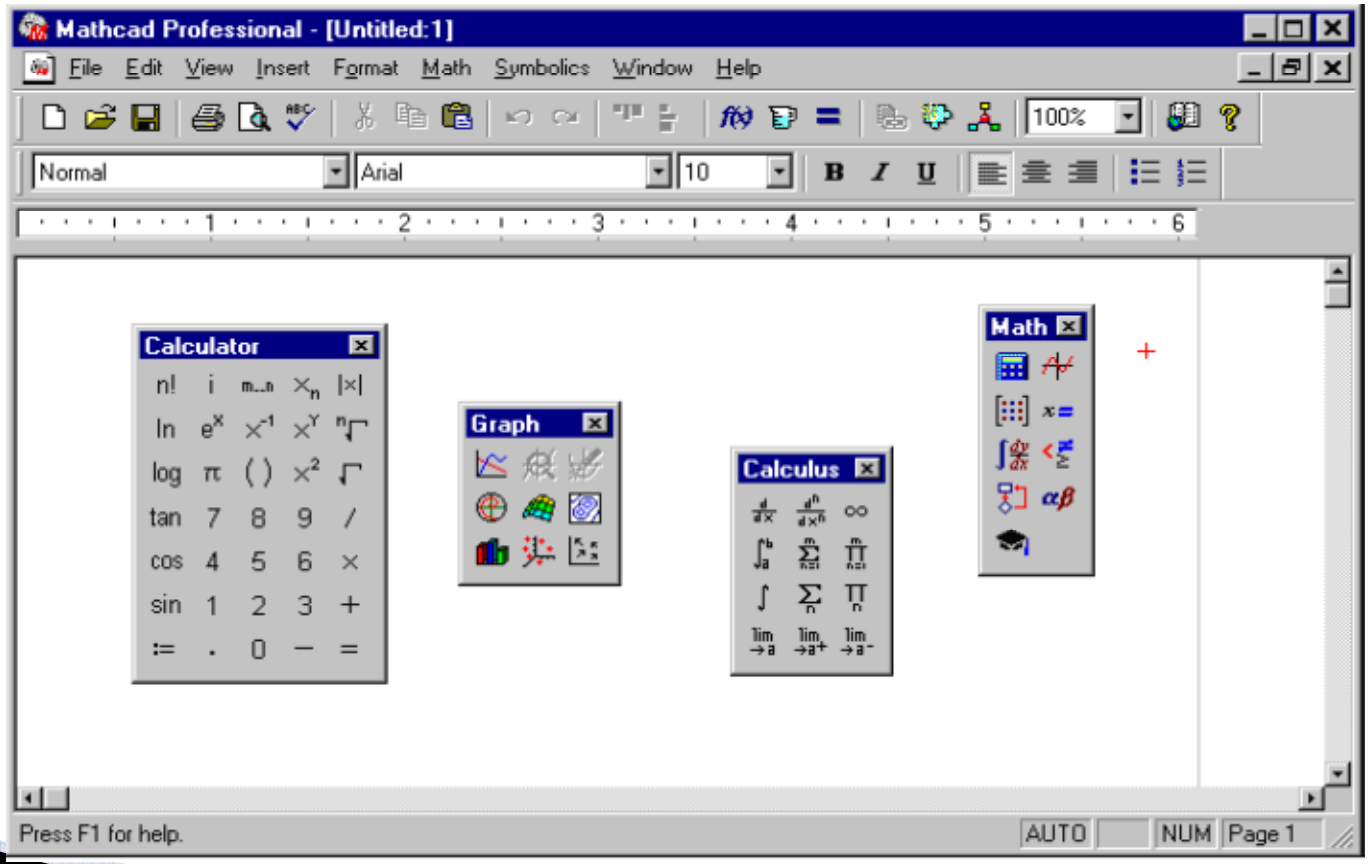
- Mathcad has the ability to show equations and results in a useful form.
- Equations and results on Mathcad are shown in the same way people are use to read them. The solution method is obvious.
- Equations and results from Mathcad can be inserted into other programs, as word processors, for more formal reports.

Getting started



Mathcad Fundamentals

- The Mathcad workspace

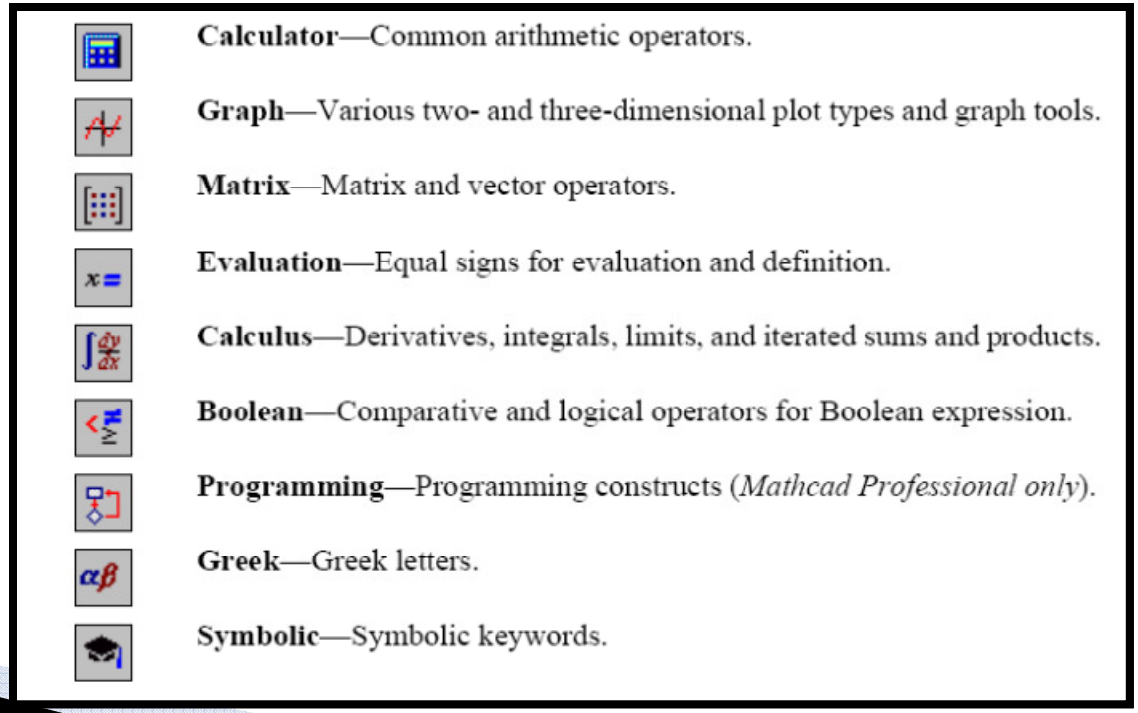


Mathcad Math Toolbar

Standard Toolbar

Formatting Bar

Math Toolbar



Calculator—Common arithmetic operators.

Graph—Various two- and three-dimensional plot types and graph tools.

Matrix—Matrix and vector operators.

Evaluation—Equal signs for evaluation and definition.

Calculus—Derivatives, integrals, limits, and iterated sums and products.

Boolean—Comparative and logical operators for Boolean expression.

Programming—Programming constructs (*Mathcad Professional only*).

Greek—Greek letters.

Symbolic—Symbolic keywords.

Controlling the order of equations in Mathcad

- MathCAD evaluates equations from left to right and top to bottom

Left to right

Top to bottom

- Anchor point for each equation, located to the left of first character at the baseline

Mathcad Equality

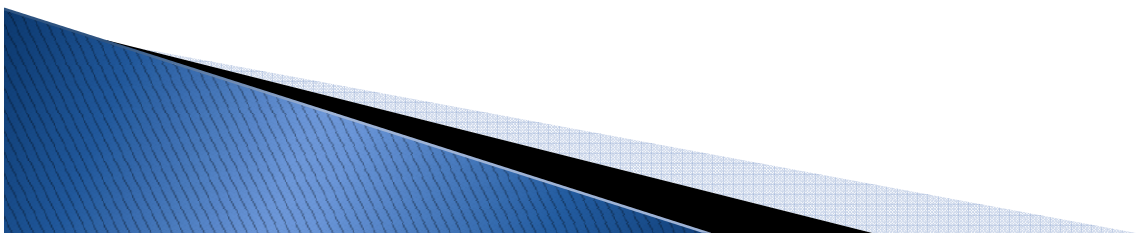
In Algebra:

"=" means that left hand side is equal to right hand side.

In Programming Context:

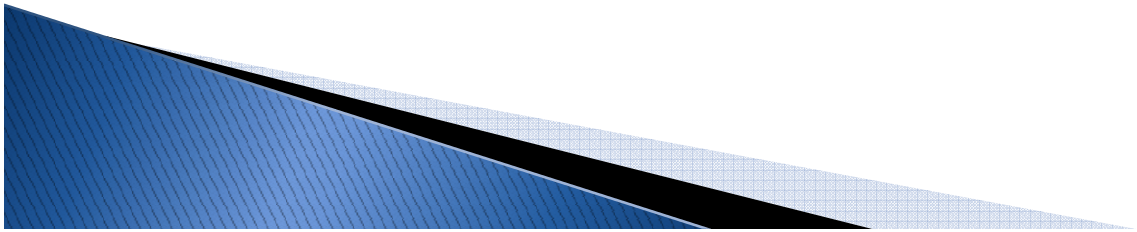
"=" means "assignment"

ex : count = count + 1.



Mathcad's Four Equal Signs

Name	Symbol	Keystroke	Usage
Assignment Operator	:=	[:] (colon)	Use to define new variables.
Evaluation Operator	=	[equal]	Use to display the value assigned to a variable, or the result of a calculation.
Symbolic Equality Operator	**=** (bold=)	[Ctrl=]	Used to show the relationship between variables in a equation (algebraic equality)
Global Assignment Operator	≡	[~] (tilde)	Operates like the regular assignment operator, except global assignments (variable definitions) are performed before evaluating the rest of the worksheet.



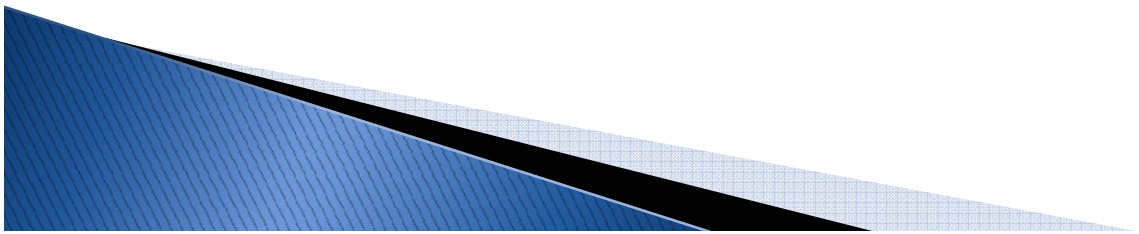
Math Operators

Calculator Toolbar

Symbol	Name	Short Key
+	Addition	+
-	Subtraction	-
*	Multiplication	[shift8]
/	Division	/
e^x	Exponentiation	
1/x	Inverse	
X^y	Raise to a power	[^] or [shift6]
n!	Factorial	
√	Square root	\
	N^{th} root	[ctrl\]

Operator Precedence Rule

Precedence	Operator	Operation
First	^	Exponentiation
Second	* , /	Multiplication-division
Third	+ , -	Addition-Subtraction



Entering and Editing Text

- Matchcad default is equation edit mode.
- If you type a series of letters and then a space, Mathcad will recognize that you are entering text.
- To create a text region:
  - Position the edit cursor (crosshair) in the blank portion of the worksheet.
  - Press [“] (the double-quote key).
  - Insert the desired text.

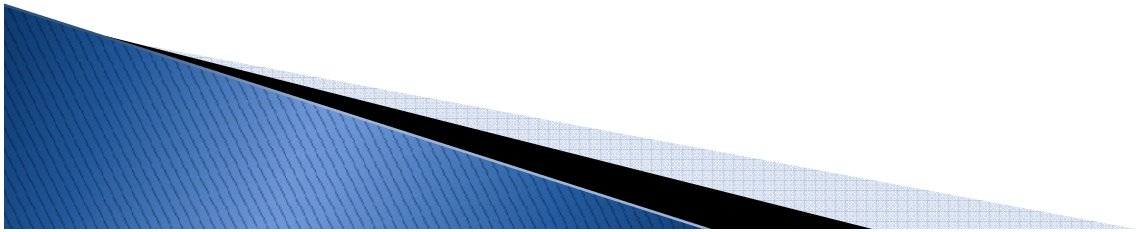
Text and Matrix Subscripts

- Matchcad allows two types of subscripts on variables, text subscripts and matrix subscripts
- Text subscripts are use to help identify variables. This type of subscript is entered by typing a period [.] before the subscript text, so A_{side} is entered as: A.side
- Matrix index subscripts are used to identify particular elements of an array (a vector or matrix). These subscripts are entered by typing a left bracket [[ ] before the subscript text. A21 is entered as A[21

Modifying Equations

- Selecting an Equation:
  - Selecting an equation for editing: *Click on the eq*.
  - Selecting an equation for moving or deleting: *drag-select the equation.*

- Selecting part of an equation:
  - Vertical editing line, *move it using the arrows keys or by clicking with the mouse.*
  - Horizontal editing line, *pressing [Space] increases the length of the horizontal line to include a greater portion of the equation.*



Modifying Equations (Cont.)

- Highlighting a region
  - Select the equation as for moving or deleting.
  - Right click on it and select properties, then select Highlight Region and choose color.

- Changing the way operators are displayed:
  - Right click on an equation directly over the operator, select View Definition As, change operator symbol.
  - To change the appearance of all operators on a worksheet, use the Worksheet Options dialog from the Tools menu and click on the Display tab.

Working with Units

- Mathcad supports the following system of units:
  - SI–Default units
  - MKS–(meter, kilogram, second)
  - CGS(centimeter, gram, second)
  - US–(foot, pound, second)
  - None (disables all built-in units, but user-defined units still work)

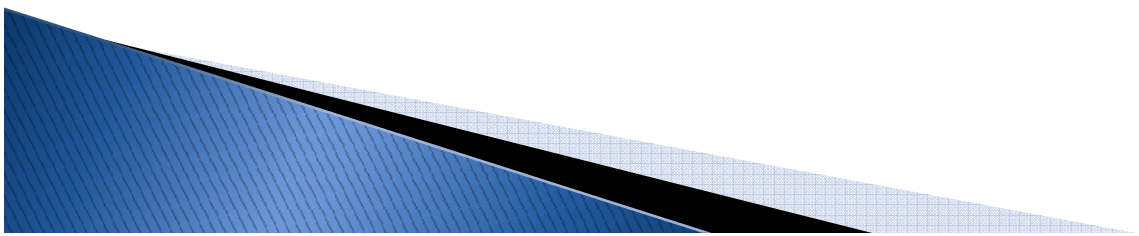
- Mathcad automatically can handle unit conversions. Values are converted from the units you enter to the base set of units (SI by default, but you can change it).

Displaying Results

- Using the Result Format dialog from the menu Format, it is possible to control:
  - The way numbers are displayed
  - The way matrices are displayed
  - The way units are displayed
- Using the Format tool bar, it is possible to modify and edit text regions in a worksheet, or edit only part of the text, as it is done in a word processor.

Saving your worksheets

- By default, Mathcad 13 saves worksheets in XML format using the file extension .xmcd.
- XML (Extensible Markup Language) is a textual data format with strong support and allows accessibility from different operating systems.
- .xmcd files are unreadable by Mathcad versions lower than 12. Files can be saved as .mcd files to be read by earlier Mathcad versions.



Mathcad Examples

1.- Defining functions:

$$\text{dist}(x, y) := \sqrt{x^2 + y^2}$$

$x1 := 0$ $\quad y1 := 1.5$

$x2 := 3$ $\quad y2 := 4$

$x3 := -1$ $\quad y3 := 1$

$\text{dist}(x1, y1) = 1.5$

$\text{dist}(x2, y2) = 5$

$\text{dist}(x3, y3) = 1.414$

$\text{dist}(3, 4) = 5$

2.- Defining arrays:

$j := 0..15$

$x_j := j^2 + 1$

$x = \begin{pmatrix} 1 \\ 2 \\ 5 \\ 10 \\ 17 \\ 26 \\ 37 \\ 50 \\ 65 \\ 82 \\ 101 \\ 122 \\ 145 \\ 170 \\ 197 \\ 226 \end{pmatrix}$

$x_0 = 1$

$x_1 = 2$

$x_3 = 10$

$x_7 = 50$

Mathcad Examples

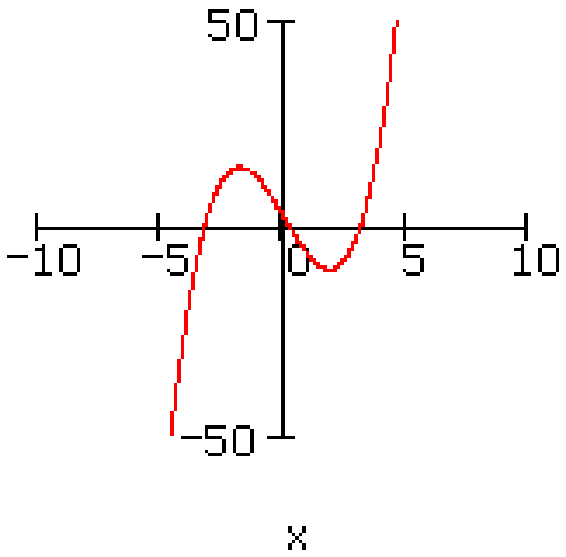
3.- Finding roots:

$$f(x) := x^3 - 10 \cdot x + 2$$

$$\text{root}(f(x), x, -5, 4) = -3.258$$

$$\text{root}(f(x), x, -2, 3) = 0.201$$

$$\text{coef} := \begin{pmatrix} 2 \\ -10 \\ 0 \\ 1 \end{pmatrix} \qquad \text{polyroots}(\text{coef}) = \begin{pmatrix} -3.258 \\ 0.201 \\ 3.057 \end{pmatrix}$$



Mathcad Examples

4.- Solving Non-linear equations:

Guess values: $x := 1 \quad y := 1$

Given

$$x^2 + y^2 = 6 \quad x + y = 2$$

$$x \leq 1 \quad y > 2$$

$$\begin{pmatrix} xval \\ yval \end{pmatrix} := Find(x, y)$$

Solution: $xval = -0.414 \quad yval = 2.414$

Check: $xval^2 + yval^2 = 6 \quad xval + yval = 2$