



# MATHCAD Fundamentals and Functions

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EGN 1006 – Introduction to Engineering



# MATHCAD

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- MATHCAD is a problem solving environment that can be used to solve a variety of MATH based problems
- It allows the user to enter mathematical problems in a WYSIWYG format
- MATHCAD allows you to solve equations on a virtual piece of scratch paper



# MATHCAD Methodology

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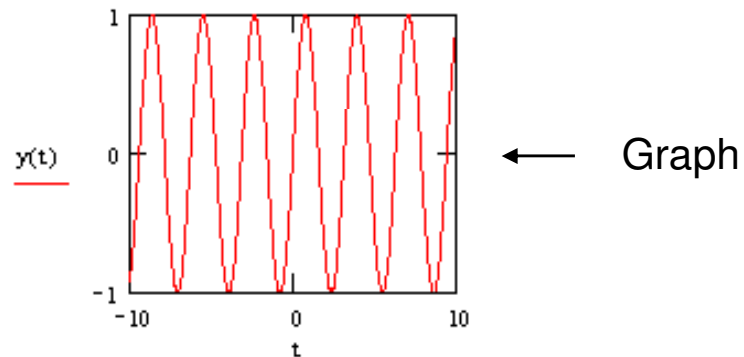
- State the problem
- Think out equations directly in MATHCAD
- Work out the problem using MATHCAD
- Vary input data if needed
- Graph data as necessary

# MathCAD: The Engineer's Scratch Pad

- Components of a MathCAD worksheet:

$\omega := 2$  ← Variable definition

$y(t) := \sin(\omega \cdot t)$  ← Equation



Note - t is time;  $\omega$  is frequency ← Text Region

- Unlike a computer program or a spreadsheet, a MathCAD document can be understood by anyone familiar with mathematics

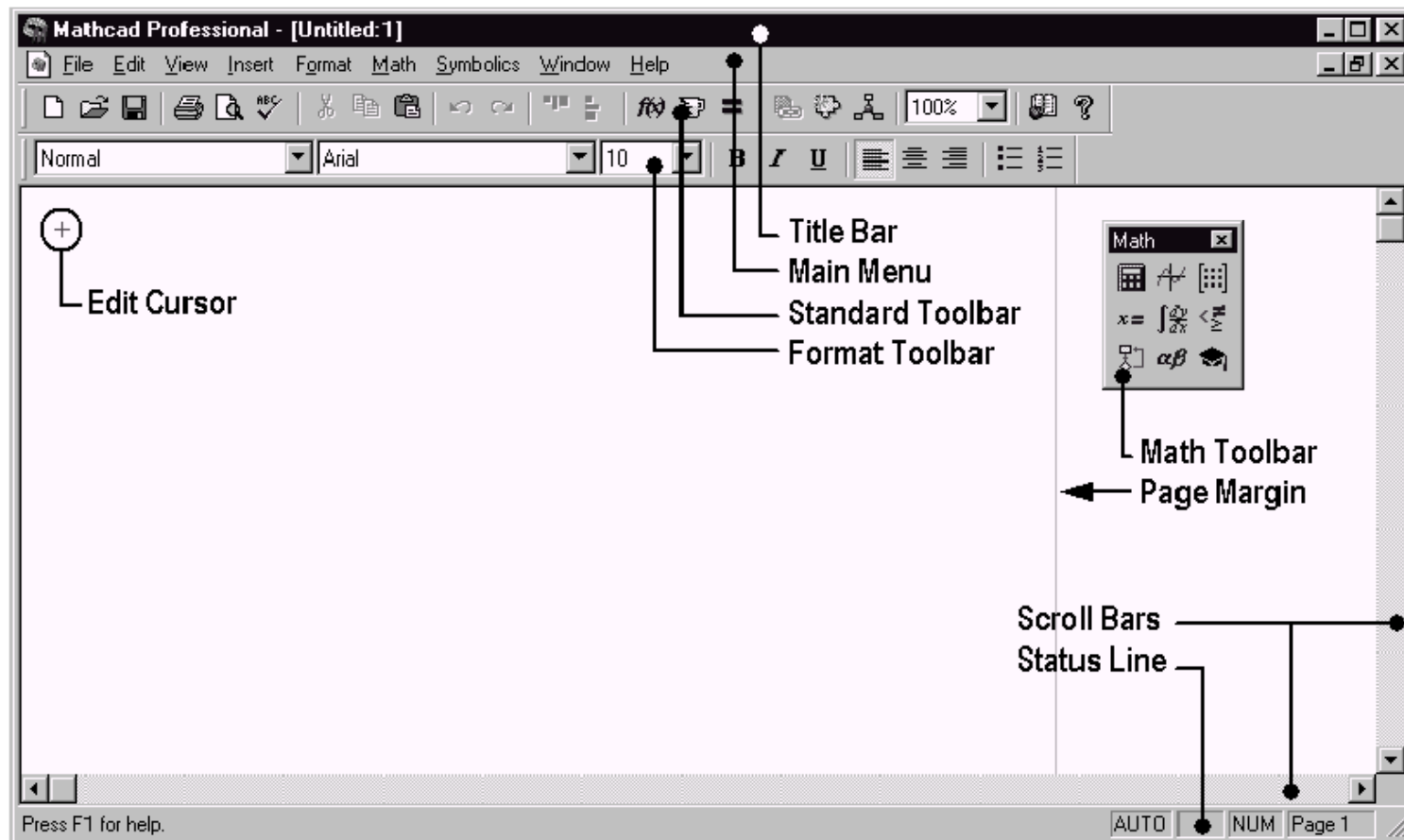


# MathCAD: The Engineer's Scratch Pad

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- MathCAD is capable of...
  - Symbolic manipulation:
    - Calculation of integrals and derivatives
    - Function simplification and factoring
    - Partial Fractions
  - Iterative solutions
  - Statistical analysis/regression
  - Matrix operations: Transpose, inverse and determinant
  - Automatic unit conversion
  - Automatic recalculation (redefining a value on the worksheet will automatically update all subsequent equations and plots)

# The MathCAD Workplace



# The MathCAD Workplace

 New Worksheet

 Save

 Print

 Check Spelling

 Cut

 Copy


 Paste

 Align Across



 Insert Function

 Calculate

 Help

 Insert Unit

 Resource Center

## Toolbars

 Greek Symbol


 Calculus

 Graph

 Calculator

 Symbolic Keyword

 Programming

 Vector and Matrix

  $x =$





# MATHCAD Tour

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Open MATHCAD on your desktop

## **One main window:**

1. Close any tutorials if you see them
2. Move the red plus cursor around with the mouse
3. The main window is your scratch pad
4. The “math” toolbar allows you to view additional toolbars: functions, graphs, etc.



# MathCAD Fundamentals

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- MathCAD includes four discrete equals signs:
  - **Assignment** ( $:=$ )
    - Enter by hitting the colon key
    - Used to define parameters (e.g.  $x := 4$ )
  - **Display** equals/calculate value ( $=$ )
    - Enter by hitting the equals key
    - Used to display the value of a variable. MathCAD returns the underlined result after the  $=$  has been typed (e.g.  $x = \underline{4}$ )
  - **Symbolic** Equality ( **BOLD**  $=$  )
    - Enter by simultaneously hitting Ctrl and  $=$  keys
    - Symbolizes a relationship between variables (e.g.  $P \cdot V = n \cdot R \cdot T$ )
  - **Global** Assignment
    - Similar to regular assignment operator ( $:=$ )
    - Available on the *evaluation toolbar*
    - Global assignment equality will be evaluated first, regardless of position on worksheet (e.g.            )



# The Equal Signs

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Move the **+** edit cursor to the upper left of the scratch pad.

Enter the following:

```
[x][:][50][*][120]
```

```
[x][=]
```

```
[y][:][x][*][0.1]
```

```
[y][=]
```



## You should see

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$$x := 50 \cdot 120$$

$$x = 6 \times 10^3$$

$$y := x \cdot 0.1$$

$$y = 600$$



# Moving and Deleting Equations

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- Select an equation to move by first clicking on the equation
- Move the cursor to the END of the equation until a HAND cursor is displayed
- Click and drag the equation to a new location
- You can also edit the equation(s) by using the arrow keys to move the BLUE cursor or you can use the mouse
- Just keep in mind that MATHCAD work everything from left to right and from top to bottom



## Using the Space Bar

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- As you enter an equation a text cursor marks your input point
- The input point can be moved using the space bar
- The arrow keys can also be used to move the text entry cursor
- If you have the input point at the beginning of an equation, when you hit delete it will delete the whole equation



# Text and Input Subscripts

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The TWO types of subscripts are:

- **TEXT SUBSCRIPT** – Used for visualization purposes only. Inserted with “.” sign ( a period)
- **INDEX SUBSCRIPT** – Used to access or define indices within an array. Inserted with the “[” sign.

Example: Enter [V].x , this represents the VELOCITY in the HORIZONTAL DIRECTION!



## MATHCAD units

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MATHCAD understands and processes a variety of units from different systems. There are two different methods for inserting units

- Using the ***insert-unit*** command from the menu
- By typing the unit next to the variable value



# Entering Units

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Enter:

`[Length][:][100][in]`

You should notice that MATCAD automatically recognizes the unit inches.

Enter:

`[Length][=]`

MATHCAD defaults to the metric unit "meters"

**Note: MATHCAD IS "CASE-SENSITIVE"**



## Changing units

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To change the unit:

- Click on the value
- Click on the black placement bar at end of unit.
- The unit menu should open and you can choose the unit you want
- Hit enter after you choose the correct unit to see the correct unit conversion in the units you selected



# MATHCAD units

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	Unit System				
	SI	MKS	CGS	US	USER
Mass	√	√	√	√	√
Length	√	√	√	√	√
Time	√	√	√	√	√
Current		NO	NO	NO	NO
Charge	NO	√	√	√	√
Temperature	√	√	√	√	√
Luminosity	√	NO	NO	NO	NO
Substance	√	NO	NO	NO	NO



# Predefined Constants

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$$\pi = 3.14159265\dots$$

$$e = 2.718281\dots$$

$$g = 9.8 \text{ m/s/s}$$



## Entering Text

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Entering text regions in MATHCAD can be done in three different ways

- Typing a quotation mark [“”]
- By selecting insert → Text Region from the pull down menu
- By pressing the space bar after typing parts of the text.



# Range Variables

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A variable may be defined to automatically contain a range of values

- For example: if you want variable  $i$  to go to 0 to 10 enter this:

```
[i][:][0][;][10]
```

```
[i][=]
```

- For example: if you want  $j$  to go from 0 to 10, but in increments of 0.25 enter this:

```
[j][:][0][,][0.25][;][10]
```

```
[j][=]
```

**The comma after the zero will display the appropriate increments**

**To see ALL of the values click INSIDE the box and use the scroll bar. MATHCAD will only display so many numbers.**

# You should see...

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$i := 0..10$

$j := 0, 0.25..10$

$i =$

0
1
2
3
4
5
6
7
8
9
10

$j =$

0
0.25
0.5
0.75
1
1.25
1.5
1.75
2
2.25
2.5
2.75
3
3.25
3.5



# Functions

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- MATHCAD can be used to create functions of variables seamlessly by specifying what variables a function will consist of by using parenthesis

For example Enter:

**$d(x,y) := x + y^2$**

Try evaluating the function by:

**$d(1,2) =$**       You should get 5!



# Built in Functions

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MATHCAD has a variety of predefined built in functions such as trigonometric, logarithmic, and exponential etc.

- For example enter the function:

$$y(x) := 3\sin(x)$$

Evaluate it:

$$y(30) = \quad \text{You should get } -2.964$$

WHY? The default unit in MATHCAD for angular measure is RADIANS



## Built in Functions

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Notice that the sine of 30 degrees is  $\frac{1}{2}$ . Therefore, trig functions require arguments in radians

- 0 degrees = 0 radians
- 180 degrees =  $\pi$  radians
- 30 degrees =  $\pi/6$  radians

Enter the following to check

**$\gamma(\pi/6)$**  = you should get 1.5



# Other Built in Functions

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- $\exp(x)$
- $\log(x)$
- $\ln(x)$
- $\sin(x)$
- $\cos(x)$
- $\tan(x)$
- $\sec(x)$
- $\csc(x)$
- $\cot(x)$

ALL ARE CASE SENSITIVE!



# Inverse Trigonometric Functions

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- $\text{asin}(x)$
- $\text{acos}(x)$
- $\text{atan}(x)$

This states, “ What angle has the sin of (#) ”?



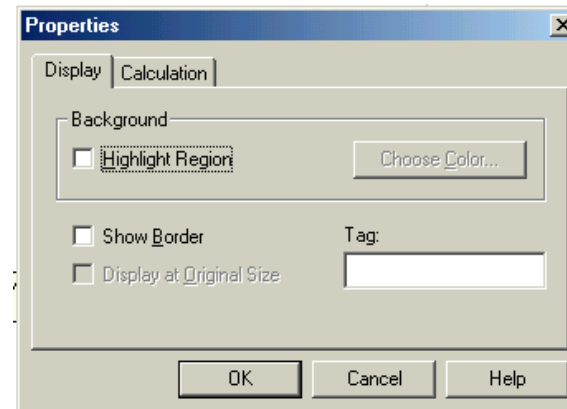
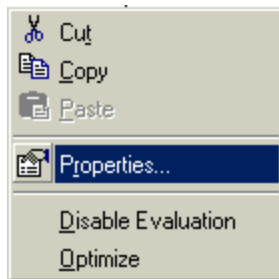
# Entering DECIMAL Values

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Decimal	A:=12	A =
Octal	A:=12o	A=
Hexidecimal	A:=12h	A=
Binary	A:=1011b	A=

# Highlighting a region

- **Highlighting a region**
  - **Allows different colors or borders to be used so that a particular result will stand out**
  - **To highlight a result, right-click on it, and select *Properties* from the pop-up menu**
  - **Choose the desired option in the dialog box appears**





## Complete the following

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Practice problems on page 22

Simple edit session Steps 1-4 pg 30

Practice problems pg 31

End of Chapter Problems – Pg 33 1,2,7

(start a NEW Mathcad document for these)

#10,11