Lecture 3

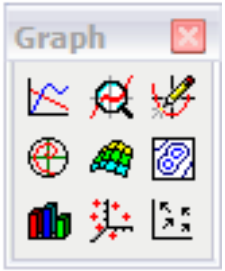
MATHCAD-DATA ANALYSIS FUNCTIONS

Objectives

- Graphs in MathCAD
- Built-in Functions for basic calculations:
  - Square roots,
  - Systems of linear equations
  - Interpolation on data sets
  - Linear regression
- Symbolic calculation

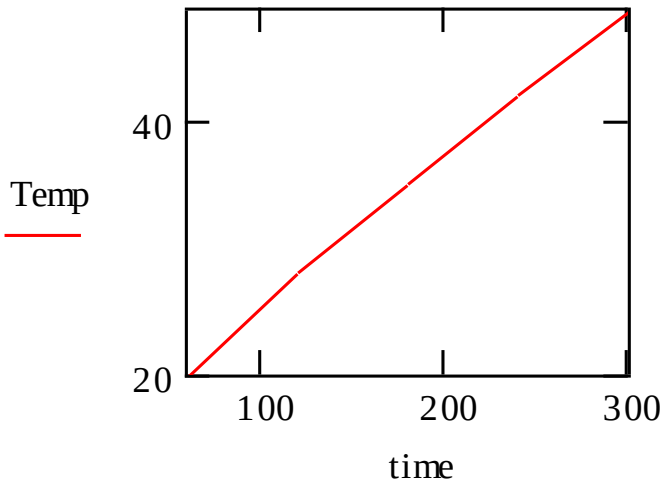
Graphing with MathCAD

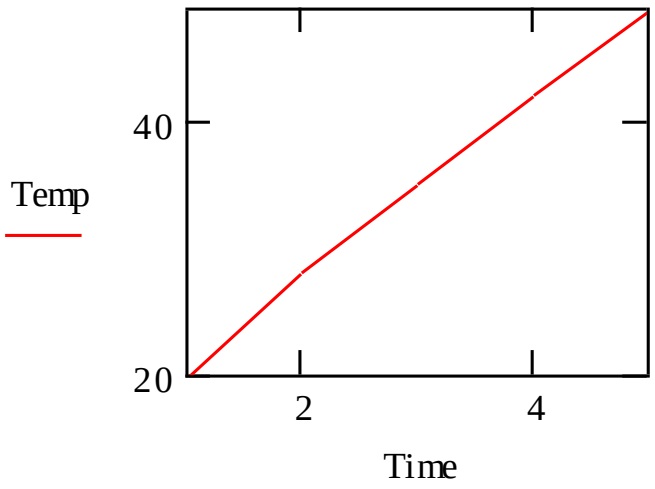
- Plotting vector against vector:
  - The vectors must have equal number of elements.
  - MathCAD plots values in its default units.
  - To change units in the plot……?
  - Divide your axis by the desired unit.
  - Or remove the units from the defined vectors
  - Use Graph Toolbox or [Shift-2]
  - Or ***Insert/Graph*** from menu



Graphing

$$time := \begin{pmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{pmatrix} min \qquad Temp := \begin{pmatrix} 20 \\ 28 \\ 35 \\ 42 \\ 49 \end{pmatrix} K \qquad Time := \frac{time}{min}$$



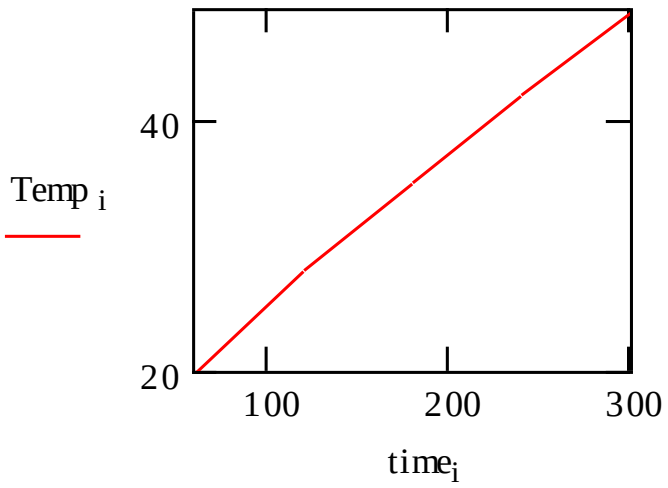


Graphing with MathCAD

- Plotting element by element: define a range variable containing as many element as each of the vectors.
- i:=0..4

$$time := \begin{pmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{pmatrix} min \qquad Temp := \begin{pmatrix} 20 \\ 28 \\ 35 \\ 42 \\ 49 \end{pmatrix} K$$

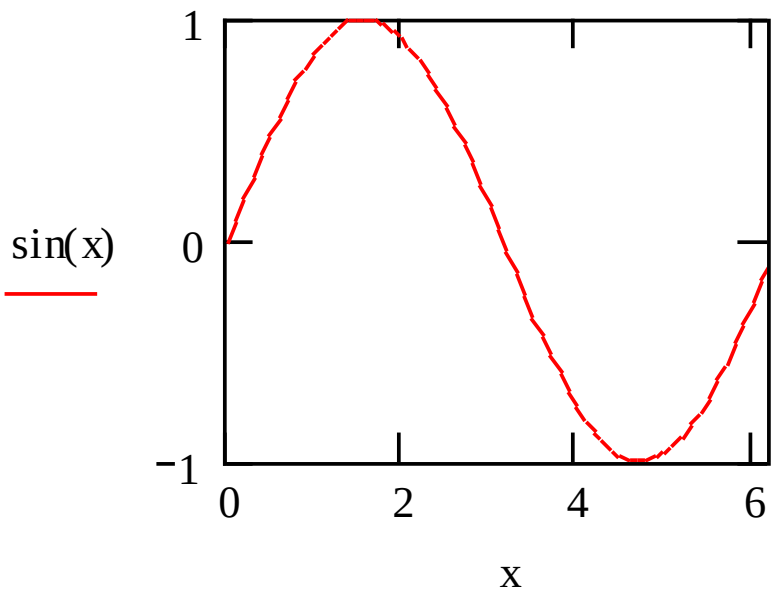
$$i := 0..4$$



QuickPlots

- Use when you want to see what a function looks like
- Create a x-y graph
- Enter the function on y-axis with parameter(s)
- Enter the parameter on x-axis

$x := 0, 0.1 .. 2\pi$

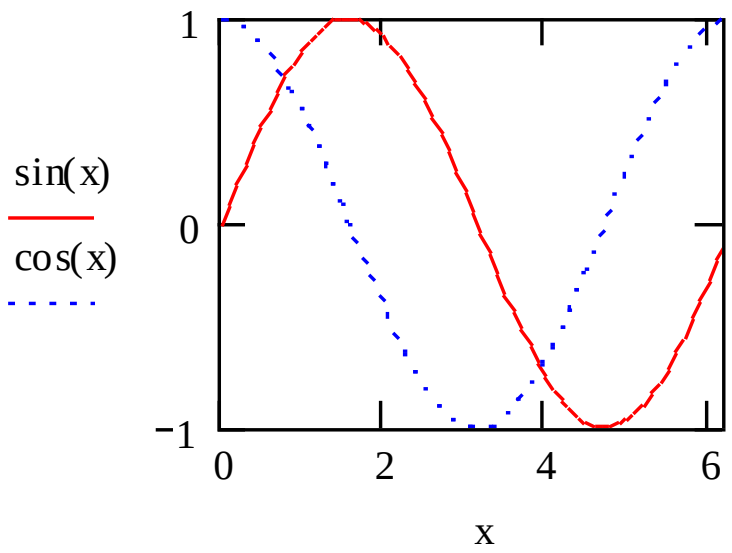


Graphing with MathCAD

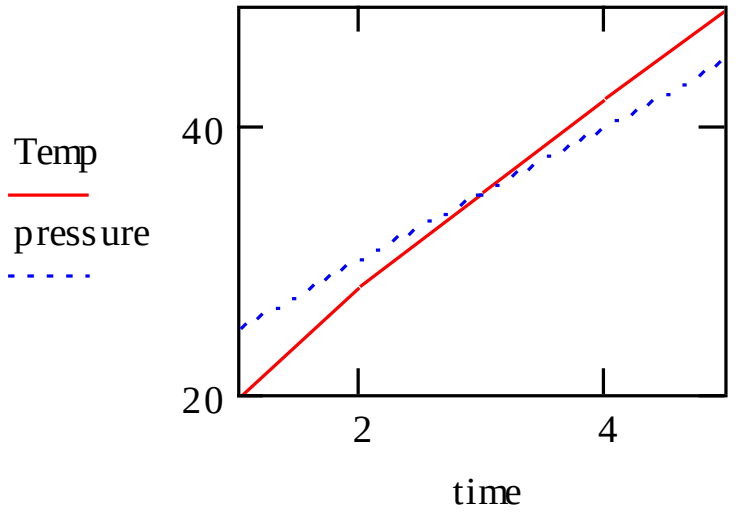
- Plotting multiple curves:up to 16 curves in a single graph.
- Example: For 2 dependent variables (y) and 1 independent variable (x)
  - Press shift2 (create a x-y plot)
  - On the y axis enter the first y variable then press comma to enter the second y variable.
  - On the x axis enter your x variable.

Multiple curves

$x := 0, 0.1 .. 2\pi$

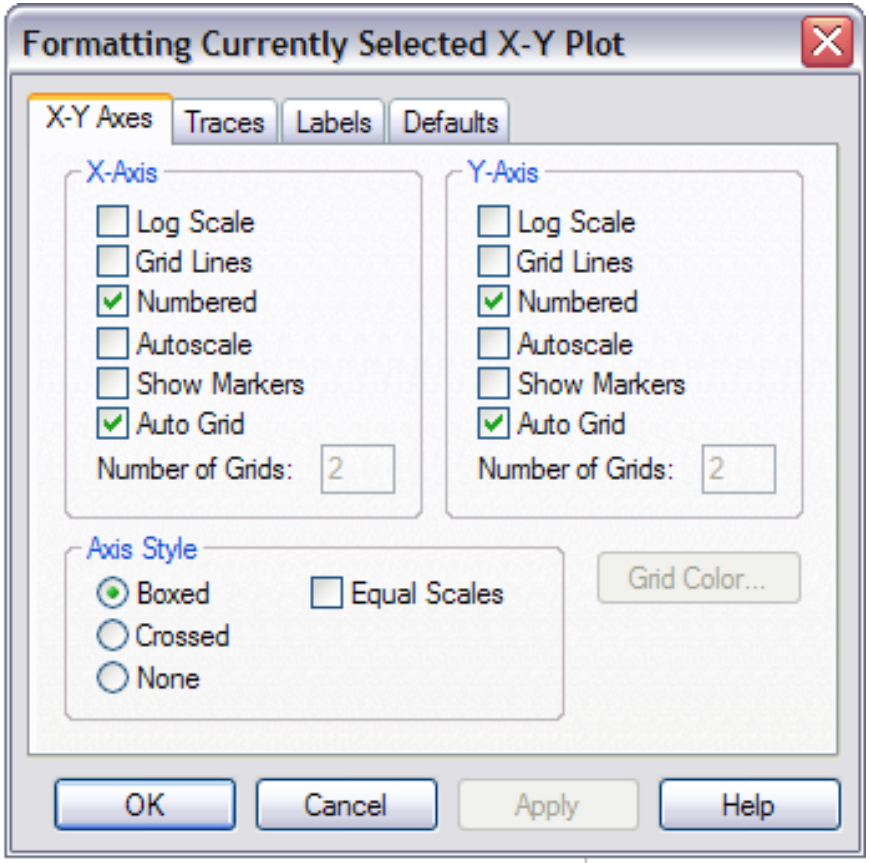


$$time := \begin{pmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{pmatrix} \quad Temp := \begin{pmatrix} 20 \\ 28 \\ 35 \\ 42 \\ 49 \end{pmatrix} \quad pressure := \begin{pmatrix} 25 \\ 30 \\ 35 \\ 40 \\ 45 \end{pmatrix}$$



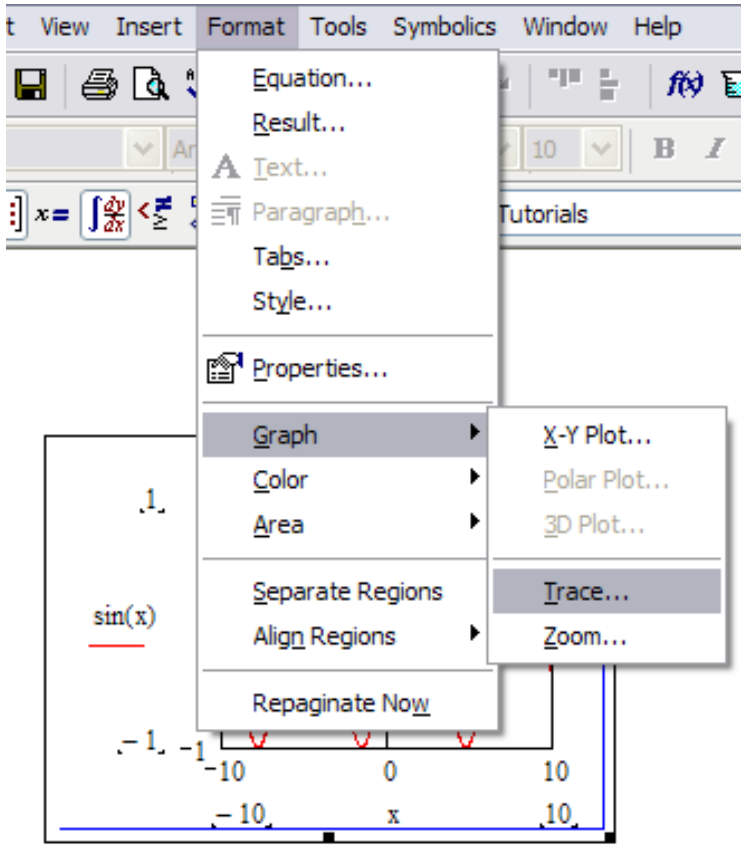
Modify Graphical Display

- Double-click anywhere on the graph
- Can change the ***axis*** characteristics
- Can change the ***trace*** characteristics
- Can add text and position of ***labels***

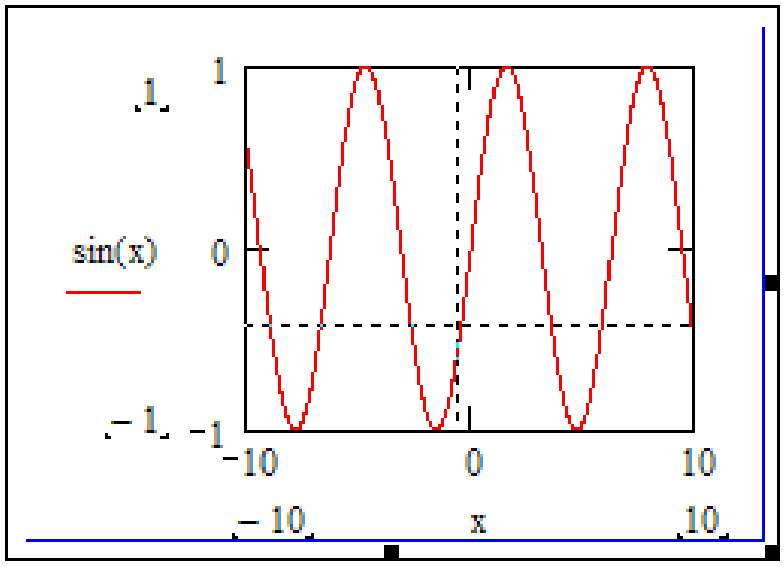


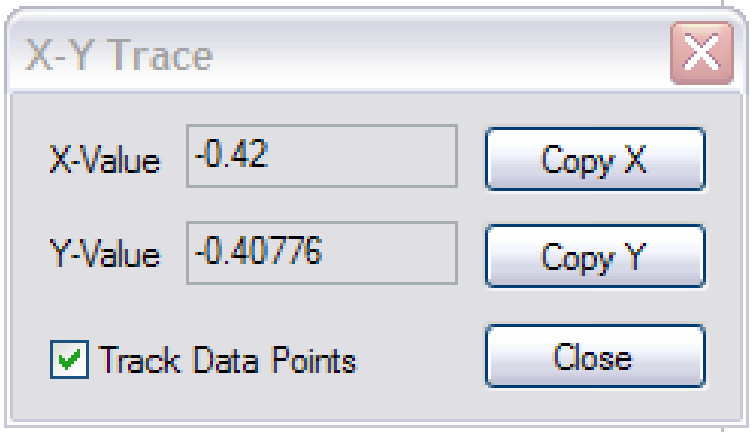
Read data from the graph

- Click anywhere on the graph
- Choose Format/Graph/Trace from menu
- Click on any point on the curve to get x and y values



Read data from the graph





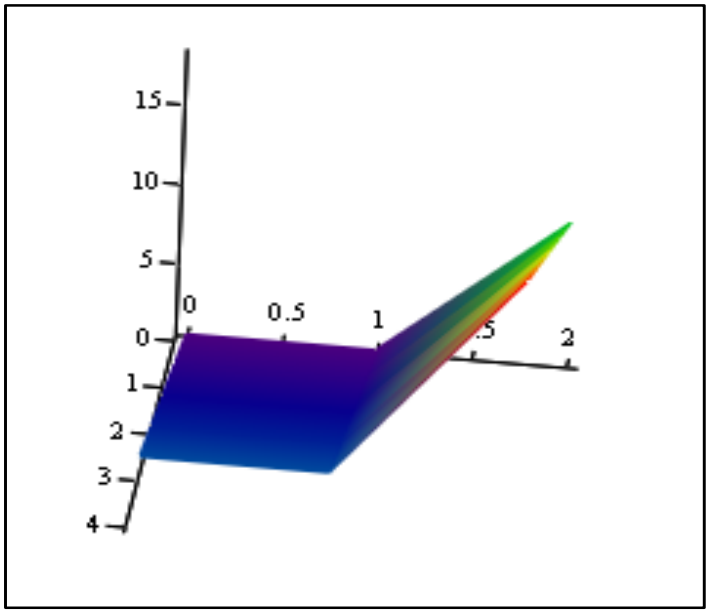
Make a Polar Plot of $\cos\left(\frac{3}{2}\theta\right)$

where the range of θ is from
-2π to 2π with an increment of 0.1.

3D Plots

- Define the matrix of elements to plot
- Choose ***Insert/Graph/Surface plot*** from menu
- Place the name of the matrix in the placeholder

$$M := \begin{pmatrix} 1 & 1 & 10 \\ 2 & 2 & 12 \\ 3 & 3 & 14 \\ 4 & 4 & 16 \\ 5 & 5 & 18 \end{pmatrix}$$



M

Make (a) a 3-D surface plot filled with grayscale color map and (b) a contour plot of the matrix T.

$$T = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 12 & 27 & 43 & 46 & 42 & 21 & 0 \\ 0 & 22 & 52 & 100 & 100 & 100 & 42 & 0 \\ 0 & 25 & 57 & 100 & 100 & 100 & 46 & 0 \\ 0 & 22 & 52 & 100 & 100 & 100 & 42 & 0 \\ 0 & 12 & 27 & 43 & 46 & 42 & 21 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Built-in functions

- **Calculation of square roots**:
- use root (y(x1),x1), where x1 is guess value.
- root (y(x1), x1) finds root of a function by approximation to the root value.
- if the expression has multiple roots, try different guess values

Calculate the roots of $ax^2+bx+c=0$ where a = 1, b = 3 and c = -2

$a := 1$ $b := 3$ $c := -2$

$f(x) := a \cdot x^2 + b \cdot x + c$

$x1 := 1$ $x2 := -3$

$soln1 := root(f(x1), x1)$ $soln2 := root(f(x2), x2)$

$soln1 = 0.562$ $soln2 = -3.562$

Built-in functions

- To **solve a linear systems of equations**:
- [C] . [x] = [r]
- use $[x]:= [C]^{-1}.[r]$
- use lsolve:
  - x:=lsolve (C,r)

$$C := \begin{pmatrix} 2 & 3 & 1 \\ 1 & 4 & 7 \\ 3 & 7 & 7 \end{pmatrix} \qquad r := \begin{pmatrix} 12 \\ 16 \\ 18 \end{pmatrix}$$

$$x := \text{lsolve}(C, r)$$

$$x = \begin{pmatrix} 34 \\ -22 \\ 10 \end{pmatrix}$$

Built-in functions

- **Statistical Functions**: mean(A), var(A), stdev(A).
- **Curve Fitting:**
  - Linear regression
  - Specialized regression equations: Exponential, power, sin, etc.

Curve fitting

- slope(x,y) returns the slope of line that best fits data in **x** and **y**.
- intercept(x,y) returns the intercept line that best fits data in **x** and **y**.
- corr(x,y) returns the correlation coefficient of the elements in **x** and **y**. (tells you how good or bad is the fit)

$$x := \begin{pmatrix} 0 \\ 1 \\ 3 \\ 4 \end{pmatrix} \qquad y := \begin{pmatrix} 0 \\ 2.6 \\ 23.16 \\ 27.57 \end{pmatrix}$$

$m := \text{slope}(x, y)$

$c := \text{intercept}(x, y)$

$m = 7.57$

$c = -1.808$

$\text{corr}(x, y) = 0.984$

$f(x) := m \cdot x + c$