

# Mathematica for Calculus 3

To start Mathematica, double click the program icon. This will open a window entitled Untitled-1. You may now type in an instruction such as:

15!

then hit **SHIFT RETURN** to evaluate it.

Usually, when you want to print you will need just certain calculations rather than your whole Mathematica session. For this, use Print Selection under the file menu. Select the selection you want to print by clicking on the bracket to the right of it. (Use control click to select more than one bracket.)

To get help click on the ? in the upper right corner.

To Print specific results from your Mathematica session, Shift click on the brackets of the cells you want to print, and then use **PRINT SELECTION** under the **FILE** menu.

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## Notes on Notation

**CAPITALS MATTER** in Mathematica. Typically, built in commands and names (such as Integrate, PlotStyle, Pi) start with the first letter of EachWord Capitalized. You can name your variables using either capitals or lower case, but COST, Cost, and cost would all be different variables.

Trig functions are Sin[x], Cos[x], etc. e is E, pi is Pi, and i is I.

*Mathematica* automatically creates something of an outline structure for your session. This is indicated by the brackets on the right. You can select a cell by clicking on it. If it is a cell that can be evaluated (note the triangle at the top of the bracket), you can then evaluate it by Shift Return. You could also edit it, delete it, copy or move it (use the pull-down edit menu), or minimize or restore it (click twice).

Symbols: \* or space      for multiplication of numbers,  
/                            for division of numbers  
^                            for exponentiation  
( )                          to indicate order of evaluation  
[ ]                          used with functions and commands  
{ }                          to indicate lists  
%                            to indicate the result of the last calculation performed  
%%                          indicates result of the second to last calculation performed,  
and etc.

## Graphics

The Plot3D command will graph functions of 2 variables:

```
Plot3D[x^.5 y^.5, {x, 0, 100}, {y, 0, 100}]
```

You can include more than one function in your graph, and also set some characteristics of the plot as follows:

```
Plot3D[{x + y, 1 - x^2 - y^2}, {x, -2, 1}, {y, -2, 1}, PlotRange -> {-4, 2}, AxesLabel -> {x, y, z}]
```

You can manipulate the graphics with your mouse to change the point of view. If you do, it is a good idea to include the AxesLabel command as above to keep track of which axis is which.

The ContourPlot command will show level curves of the surface. You can use the **Contours**-> command to specify which level curves you want to see. If you leave it blank, you will see 10 equally spaced heights.:

```
ContourPlot[x^.5 y^.5, {x, 0, 100}, {y, 0, 100}, Contours -> {20, 40, 60}]
```

The ParametricPlot3D command will graph vector valued functions. Here is an example:

```
ParametricPlot3D[{Cos[t], Sin[t], t}, {t, 0, 4 Pi}]
```

*Mathematica* can graph in cylindrical and spherical coordinates too.

For a plot in spherical coordinates, you use SphericalPlot3D, and enter first the formula for rho in terms of theta and phi, then the ranges on theta and phi, as follows:

```
SphericalPlot3D[2 + Sin[3 theta] Sin[3 phi],  
{theta, 0, Pi}, {phi, 0, 2 Pi}, PlotPoints -> {40, 60}]
```

For a plot in cylindrical coordinates, use RevolutionPlot3D, and enter first the formula for z in terms of r and theta, then the ranges on r and theta, as follows:

```
RevolutionPlot3D[r^2 + 1, {r, 0, 2}, {theta, 0, 2 Pi}]
```

## Calculus

To do derivatives:

```
D[Exp[x^2], x]
```

```
D[x^2 y^3, x]
```

(Partial derivative with respect to x.)

```
D[x^2 y^3, {x, 2}]
```

(Second partial with respect to x.)

```
D[x^2 y^3, x, y]
```

(This differentiates first with respect to y, then with respect to x.)

and integrals:

`Integrate[x^2 y^3, x]`

(Indefinite integral with respect to x)

`Integrate[x^2 y^3, {x, 0, 2}, {y, 0, x}]`

(Definite integral, with respect to y first--so dydx.)

To find sums or partial sums of series:

`In[2]:= Sum[1/n^2, {n, 1, Infinity}]`

## Algebra

You can name an expression:

`Cost = 3 x - .0001 x^2 + 2 y`

and then refer to it later to evaluate, differentiate, or graph it. To evaluate it use the following structure:

`Cost /. {x -> 100, y -> 50}`

You can sometimes find a solution to a system of equations using `Solve` as follows (note the double equals in the equations):

`Solve[{2 x - y == 7, x + y == 3}, {x, y}]`

If the equations cannot be solved exactly, you can sometimes solve them numerically using `NSolve`:

`NSolve[{x^4 - 2 y^2 == 2, y^3 + x^3 == 1}, {x, y}]`

You can solve two equations like  $z=x^2+y^2$  and  $z=x+y$  simultaneously for the curves of intersection,  $y$  in terms of  $x$ , using `Solve` as follows:

`Solve[x^2 + y^2 == x + y, y]`

$\left\{ \left\{ y \rightarrow \frac{1}{2} \left( 1 - \sqrt{1 + 4x - 4x^2} \right) \right\}, \left\{ y \rightarrow \frac{1}{2} \left( 1 + \sqrt{1 + 4x - 4x^2} \right) \right\} \right\}$