Basic Mathematica Tools (Intro)

As reminder of mathematica make a mathematica notebook of the following commands. Execute each command.

- To open mathematica session:
  - on windows : Windows-Symbol on bottom left → All Apps → Wolfram Mathematica
  - on linux: (a) Applications (top left on screen) → Programming → *Mathematica* 10.1 OR (b) from command line in terminal type **mathematica &**
- Execute each command with **Shift + Enter**
- Help: Use pull-down menu, OR, if you know command name, e.g. **Plot**, just type **?Plot**, and navigate to the examples.
- *Mathematica* notebooks are organized in cells (which can contain more than one command).
  A semicolon at the end of a command suppresses the output of the command.
  Cells can be grouped into units like Sections using the Format menu

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Arithmetic

```
2+3
```

```
2*3
```

Now type a 2, followed by a space, followed by a 3.

```
7!
```

```
1/3
```

```
1./3 (*Notice the difference *)
```

```
N[1/3]
```

```
1/3//N
```

```
Pi
```

```
Pi//N
```

```
π//N (* You can get the π symbol  using  Esc pi Esc , or with Palettes *)
```

```
N[π, 1000]
```

```
Sqrt[27]
```

```
Sqrt[27.]
```

```
Sqrt[27]//N
```

$\sqrt{27.}$ `(* Entered using a Palette *)`

Algebra

```
Expand[(a+b)^3]
```

```
Factor[x^2-x-6]
```

```
Solve[x^2-x-6 == 0, x]
```

```
Solve[x^5-x^2+6 == 0, x]
```

```
NSolve[x^5-x^2+6 == 0, x]
```

Lists, Vectors, and Matrices

The following are two "lists" of 3 numbers.The lists has been given the names "v" and "w"

```
v = {5, 10, 11}
w = {-1, 4, 2}
```

```
MatrixForm [v]
```

```
v[[1]]
```

```
w[[3]]
```

```
v[[4]]
```

```
z = v+w
```

The dot product is done with a period between the vectors :

```
v.w
```

The following is a "list of lists"
The individual lists can be interpreted as rows of a matrix.

```
m  = {{1, 2}, {3, 4}}
```

```
MatrixForm [m ]
```

```
m [[2, 1]]
```

```
MatrixForm [Inverse[m ]]
```

```
MatrixForm [m .Inverse[m ]]
```

```
MatrixForm [Transpose[m ]]
```

Data Analysis :

```
a = {3.2, 1.6, 9.8, 10.3, 2.1};

Mean[a]

StandardDeviation[a]
```

Let's confirm, the definitions of Mean and Standard Deviation:

```
Length[a]

Sum [a[[i]], {i, 1, Length[a]}]

Total[a]

Total[a]/Length[a]

Sqrt[Sum [(a[[i]] - Mean[a])^2, {i, 1, Length[a]}]/(Length[a] - 1)]
```

Defining Functions :

```
f[x_] := xSin[x]
```

The colon in the ":=" above should be used by default; it delays evaluation of the function definition until the function is actually called.

```
f[1.1]
```

Simple Plots

Plotting functions

```
Plot[x^3 - x^2, {x, -1.0, 1.5}]

Plot[f[x], {x, -0.5, 1.5}]
```

Plotting Data

```
a = {{-0.5, 0.28}, {-0.25, 0.03}, {0., -0.1},
      {0.25, 0.08}, {0.5, 0.3}, {0.75, 0.4}, {1., 0.85}};

MatrixForm [a]

ListPlot[a]
```

Combining Plots

Give "names" to output (with semicolons to suppress output) :

```
graph1 = Plot[f[x], {x, -0.5, 1.5}];
graph2 = ListPlot[a];
Show[graph1, graph2]
```

Other Kinds of Plots

```
ParametricPlot [{Cos[t], Sin[t]}, {t, 0, (3 π) / 2}]
```

```
Plot3D[Sin[x] Cos[y], {x, 0, π}, {y, 0, π}]
```

Calculus

Simple Differentiation

```
f[x]
```

```
f'[x]
```

Integration

```
Clear[x, a, b] (* Necessary because of previous definitions*)
Integrate[x^3, {x, a, b}]
```

You can make thigs look pretty using Palettes :

$$\int_{a}^{b} x^3 \, dx$$

Differential Equations

```
Clear[y, x]
```

Analytical solution with undetermined constants (NOTE: ‘equals’ sign entered as ‘==’)

```
DSolve[y''[x] + 4 y[x] == 0, y[x], x]
```

Analytical solution with boundary conditions given (NOTE: ‘equals’ signs entered as ‘==’)

```
DSolve[{y''[x] + 4 y[x] == 0, y[0] == 0, y'[0] == 3}, y[x], x]
```

Generation of Lists with Table Command

```
b = Table[i^2, {i, 0, 8}]
```

```
c = Table[i^3, {i, 0, 8}]
```

```
{b, c}
```

```
MatrixForm [{b, c}]
```

```
MatrixForm [Transpose[{b, c}]]
```

Reading and Writing of File

```
Export["out.dat", {{5.7, 4.3}, {-1.2, 7.8}}];
```

```
data = Import ["magofT .dat"];
(* the file needs to be in directory where you  started mathematica   *)
```