MATHEMATICA INTRODUCTION

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The online-help is good. For example, the complete Mathematica User Manual is available via the help system. To use it though, you need to start Mathematica ...

To start Mathematica in the MCL, double-click on the Mathematica icon using the copy on the Lab System local hard disk (as loading of the Maths Lab server is currently too slow). When the Mathematica window appears, activate the kernel by entering a simple calculation (1+1) and press ENTER.  

\[
\begin{align*}
1+1 \\
2
\end{align*}
\]

i.e. it names your input (1+1) and produces an output (2). Note the outline shape of the right bracket \(]\) while Mathematica is working.

You can then proceed with your calculations.

■ A USEFUL UWA URL

UWA's Physics Dept makes extensive use of Mathematica.

The introductory Notebooks of Paul Abbott's course
e.g. Basic .. Calculations sections of the first introduction to Mathematica notebook there are another place for you to look for introductory examples. Look through this handout first, though.

■ HOW TO RUN Mathematica ON YOUR HOME PC?

There is a Student price for the software. Best place in Perth to buy is

The version of the software in use in MCL is Mathematica 4.0. Mathematica 3.0 and upwards is recommended.
HELP

1. For beginners, the most useful first item is the Getting Started from the Help menu and going to the "Tour of Mathematica" there.

2. For help with individual functions, for example with a function whose name begins with "Nam", type ?Nam*
   ??Nam* for more help,
   ?N* for help on all of the functions beginning with N..

3. For help on mathematical functions, use the Function Browser under the Help menu.

4. To stop a calculation use 'Control,'.

5. To quit, select Quit from the File menu.

6. Balloon Help can be used in connection with what is on the menus in the FrontEnd.

ELEMENTARY CALCULATIONS

\[ \pi + 2^2 + 1/2 + 3 \]
\[ \frac{33}{2} + \pi \]

An exact calculation. Note that \( \pi \) cannot be written exactly. Note that a space (or *) denotes multiplication. Note also that an initial capital letter is used for Mathematica functions. You should use small letters for the expressions you introduce. Enter needs to be pressed to complete the calculation, and labels Out[1], In[1] are introduced by the program. To get a numerical approximation use:

\[ N[\%] \]
\[ 19.6416 \]

\( N \) evaluates the expression approximately. \% denotes the previous output. \%\% the output before this etc. \%n denotes Out[n]. Note that a square bracket [] is used for arguments of functions.

VARIABLES, EQUATIONS

\[ eq = x^2 + b \cdot x + 1 \]
\[ 1 + b \cdot x + x^2 \]
\[ Solve[eq==0,x] \]
\[ \{ \{ x \rightarrow \frac{1}{2} \left( -b - \sqrt{-4 + b^2} \right) \}, \{ x \rightarrow \frac{1}{2} \left( -b + \sqrt{-4 + b^2} \right) \} \} \]
Note the \(==\) used for an equation. The single \(=\) assigns the value \(x^2 + b*x + 1\) to eq. Note that the outcome of Solve is presented as a list, the 2 solutions, in curly \{\} brackets. We can now input a particular numerical value of \(b\) (9 say) by using the operator /. and \(b\rightarrow9\) and evaluate approximately use the N operator:

\[
N[\%] /. b\rightarrow9
\]
\[
\{\{x \rightarrow -8.88748\}, \{x \rightarrow -0.112518\}\}
\]

The second solution of the above list can be extracted using double square brackets [[2]]:

\[
\%[[2]]
\]
\[
\{x \rightarrow -0.112518\}
\]

### COMMON MATHEMATICAL OPERATORS

\[
D[x^n,x]
\]
\[
n * x^{-1-n}
\]

\[
\text{Integrate}[\text{Sin}[x],x]
\]
\[
-\text{Cos}[x]
\]

### PLOTTING

\[
\text{Plot}[\text{Sin}[x],\{x,-\Pi,\Pi\}]
\]

- Graphics -

\[
p1=%
\]

This names the graph "object" p1. This can be referred to later. For example:
Show[pl, Frame->True]

The "option" Frame introduces a frame about the graph. Use ?Options to see about options. For surface and contour maps ask for help about Plot3D, ParametricPlot3D, ContourPlot. Also check up on the Show, AxesLabels, PlotLabel, Viewpoint Options.

■ LINEAR ALGEBRA

\[
m = \begin{pmatrix} a & b \\ c & d \end{pmatrix}
\]

a matrix with rows (a,b), (c,d)
It looks more like a matrix with

\[
m // \text{MatrixForm}
\]

\[
\begin{pmatrix} a & b \\ c & d \end{pmatrix}
\]

LinearSolve[m, \{e, f\}] // MatrixForm

\[
\begin{pmatrix} de-bf \\ bc-ad \\ ce-af \\ bc-ad \end{pmatrix}
\]
produces the solution of \( m x = \{e, f\} \). See Also Inverse, etc.

■ Differential Equations

Consider the initial-value problem for the LRC circuit of Stewart (3rd ed.) S15.7, Example 3, page 1007.
ans = DSolve[
{y'[t] + 40*y'[t] + 625*y[t] == 100*Cos[10*t],
y[0] == 0, y'[0] == 0},
y[t], t]

\{y[t] \to \frac{1}{697}e^{-20t}\left(84 e^{20t} \cos[10 t] - 84 \cos[15 t] + 64 e^{20t} \sin[10 t] - \frac{464}{3} \sin[15 t]\right)\}\}

yans = y[t] /. ans[[1]]
Plot[yans, {t, 0, 1.2}]

- Graphics -

Also see NDSolve[ ], for numerical evaluation. Systems of de's can also be solved.

■ THINGS TO NOTE

1. Mathematica's own functions all begin with a capital letter, and arguments are enclosed in square brackets. Variables you define should begin with a small letter.

2. x y and x*y mean x*y. xy is the variable "xy".

3. One common error is inadvertently to 'reuse' variables. For example:

   \begin{verbatim}
   x=1
   1
   \end{verbatim}

   Then one does more work, forgets one has assigned x, and wants to say, solve for an unknown in eq. Why this won't work is clear from

   \begin{verbatim}
   eq=x^2+b*x+c
   1+b+c
   \end{verbatim}

   Having forgotten about the assignment of x to 1 we've not ended up with the quadratic we expected. To unassign x use:

   \begin{verbatim}
   x=.; eq=.
   \end{verbatim}
The expression for \( eq \) we want.

4. Equations use a **double** equals sign.

There is much more to *Mathematica* than this. There are details concerning Palettes and Notebooks you may find useful. Whole 'interactive engineering handbooks' have been prepared using these facilities.

However, in M28n our approach is to encourage you to learn the CAS from applying it to help you solve typical 'engineering maths' problems, and to provide a gentle introduction via a systematic set of labs. These are at http://maths.uwa.edu.au/~keady/M28p

in a password protected area. The login is m28n, the password is m28n****