MAPLE

Module F7.1SC3

2008

SECTION 1 : Introduction

Maple can be used as a simple calculator to add, subtract, multiply, take powers and so on. Some illustrative examples are given below. Work through the examples below, and on the tutorial sheet. The only way to become proficient with MAPLE is through practice! Note: the hash key may be used for comments when working in Maple prompt mode.

1.1 MAPLE AS A CALCULATOR

We need the SEMICOLON at the end of a command to tell Maple to perform a calculation.

```
> # Adding fractions:
> 3/4 + 6/7;
```

$$\frac{45}{28}$$

```
> # Convert to decimals (10 significant figures is the default
  precision) using the command 'evalf':
> evalf(45/28);
```

$$1.607142857$$

```
> # Do this again but to 20 significant figures:
> evalf(45/28,20);
```

$$1.6071428571428571429$$

```
> # We can do this automatically by using the decimal form of the
  originals:
> 45.0/28.0;
```

$$1.607142857$$

```
> # Multiplication uses the * sign found above the 8 on the
  keyboard:
> 3*4 + 6*7;
```

$$54$$

BUILT-IN CONSTANTS AND FUNCTIONS

Maple has various built-in constants. For example pi and i represented by *Pi* and *I*.

```
> # Evaluate pi to 30 decimal places:
> evalf(Pi,30); # Notice the use of a capital P.
```

$$3.14159265358979323846264338328$$

```
> # Multiply and divide two complex numbers with the commands on
  one line, again noting the use of the capital I. Don't forget
  the *'s, Maple does not understand (4+3I) for example.
> (4 + 3*I)*(3 - 4*I); (4 + 3*I)/(3 - 4*I);
```

$$24 - 7\,I$$

$$I$$

In addition Maple has a large range of built-in functions.

```
> # Find the modulus and argument of the above complex numbers
  using 'abs' and 'argument':
> abs(24 - 7*I); argument(24-7*I); evalf(argument(24-7*I));
```

$$25$$

$$-\arctan\left(\frac{7}{24}\right)$$

$$-0.2837941092$$

```
> abs(I); argument(I);
```

$$1$$

$$\frac{\pi}{2}$$

```
> # Use of Trigonometric functions, with arguments in radians:
> cos(Pi/6);
```

$$\frac{\sqrt{3}}{2}$$

```
> evalf(cos(Pi/6));
```

$$0.8660254040$$

```
> # Use of the exponential and logarithmic functions:
> exp(3); evalf(exp(3)); ln(3); evalf(ln(3));
```

$$e^3$$

$$20.08553692$$

$$\ln(3)$$

$$1.098612289$$

```
> evalf(exp(1),15); # This gives the value of 'e'.
```

$$2.71828182845905$$

```
> # To raise to a power use the upward pointed hat key.
> # 44 squared:
> 44^2;
```

$$1936$$

```
> # Negative and fractional powers need the use of enclosing
  brackets to avoid ambiguity:
> # 4 to the power -3 and the cube root of 27:
> 4^(-3); 27^(1/3);
```

$$\frac{1}{64}$$

$$27^{(1/3)}$$

```
> # To work the last one out we use the command 'simplify' with
  the % key to recall the expression.
> simplify(%);
```

$$3$$

```
> # Square root has its own command, 'sqrt', but to get a
```

```
numerical result we may need to use 'evalf' as well:
> sqrt(50);
```

$$5\sqrt{2}$$

```
> evalf(%);
```

$$7.071067810$$

```
> # In addition to recalling the last Maple command we can step
  back twice or even three times as follows:
> sin(Pi/5); cos(Pi/5); tan(Pi/5);
```

$$\sin\left(\frac{\pi}{5}\right)$$

$$\cos\left(\frac{\pi}{5}\right)$$

$$\tan\left(\frac{\pi}{5}\right)$$

```
> evalf(%+%%+%%%); # Adds up these three results.
```

$$2.123344774$$

1.2 EXPRESSIONS IN MAPLE

SAVING EXPRESSIONS.

It is very useful to be able to save expressions for later use. The % method can be confusing particularly if items have been taken off the screen but are still in memory. Instead we use := (colon followed by equals) to assign an expression to a variable as in the following examples.

```
> # We assign a quadratic in x to the variable y:
> y:=x^2 + 5*x + 4;
```

$$y := x^2 + 5\,x + 4$$

```
> # We can calculate with this y:
> 6*y^2; cos(y);
```

$$6\,(x^2 + 5\,x + 4)^2$$

$$\cos(x^2 + 5\,x + 4)$$

CHANGING EXPRESIONS

We can re-define the above y as in the following:

```
> # Assign a new quadratic to y:
> y:=x^2 - 3*x - 4;
```

$$y := x^2 - 3\,x - 4$$

```
> # The calculations now become:
```

```
> 6*y^2; cos(y);
```

$$6\,(x^2 - 3\,x - 4)^2$$

$$\cos(x^2 - 3\,x - 4)$$

In order to be able to use similar assignment letters or words for a given question number 'n' we can add the number to the end of our LHS word as in the following:

```
> y1:= sin(y);
```

$$y1 := \sin(x^2 - 3\,x - 4)$$

REMOVING EXPRESSIONS

If we wish to use the variable for something else in the same file, and we are not sure if it is still in the system, then we can reset it by using single quotes round it as in the following:

```
> # Reset y
> y:='y';
```

$$y := y$$

```
> # We check that it has now been reset by asking Maple what its
  status is:
> y;
```

$$y$$

```
> # To clear all variables and reset the internal state of Maple
  use the restart command:
> restart;
```

POLYNOMIALS AND THE '*SOLVE*' COMMAND

Maple recognises simple polynomials and can deal with them for you.

```
> # Factorize and solve a simple quadratic:
> y2:=x^2 - 3*x - 4;
```

$$y2 := x^2 - 3\,x - 4$$

```
> c2:=factor(y2);
```

$$c2 := (x + 1)\,(x - 4)$$

```
> # We repeat this for a simple cubic:
> y3:=x^3 - 7*x + 6;
```

$$y3 := x^3 - 7\,x + 6$$

```
> c3:=factor(y3);
```

$$c3 := (x - 1)\,(x - 2)\,(x + 3)$$

```
> # Check this by 'expand'ing to get back the given y expression:
> expand(c3);
```

$$x^3 - 7x + 6$$

```
> # Now we will get Maple to find the roots using 'solve' as
  follows:
> solve(y2=0,x);
```

4, -1

```
> # In fact we can drop the RHS as follows:
> solve(y3,x);
```

1, 2, -3

```
> # When we have a sequence of solutions such as this it is often
  useful to assign them to an expression. For example:
> sols:=solve(y3,x);
```

sols := 1, 2, -3

```
> # We can get hold of each part of the solution in turn as
  follows:
> sols[1];  # first in sequence
```

1

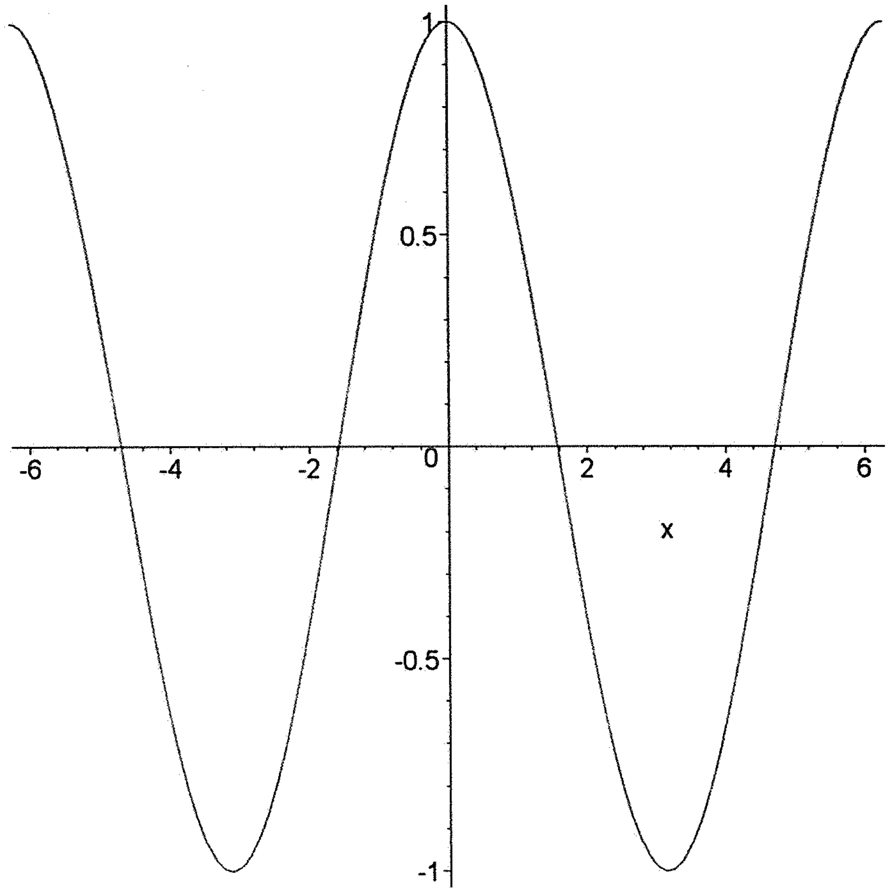
```
> sols[3];  # 3rd in sequence
```

-3

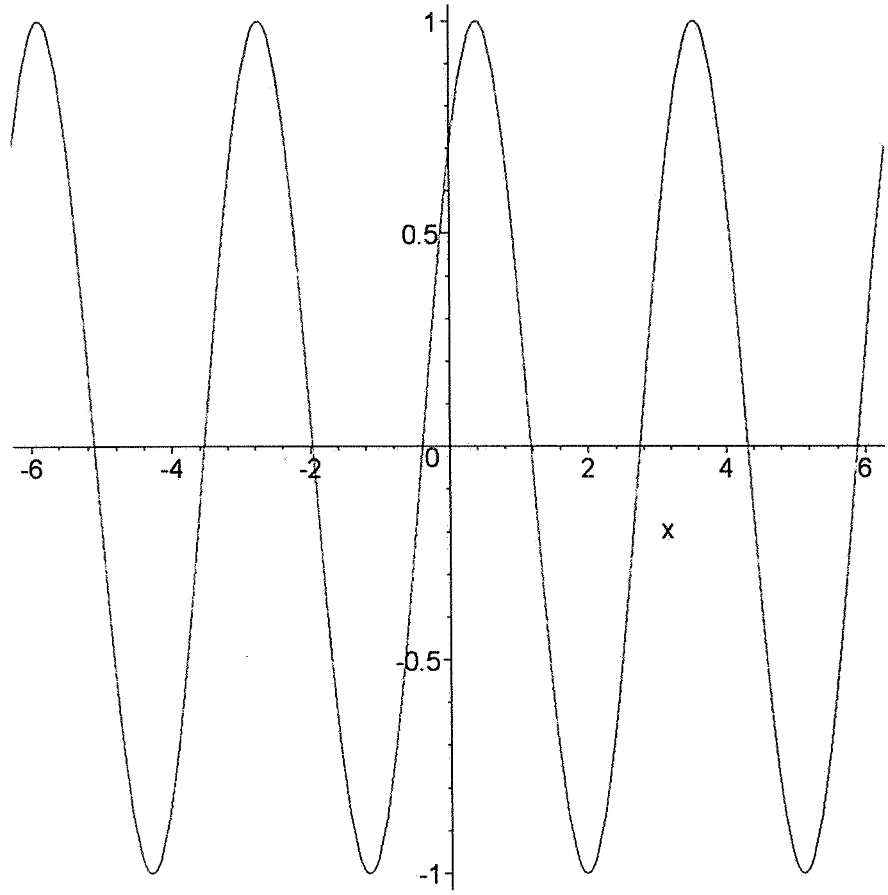
1.3 PLOTTING USING MAPLE

Maple also has a very good plotting facility. For a simple straight-forward graph with a given set of '*x*' values we use the command `*plot*'.

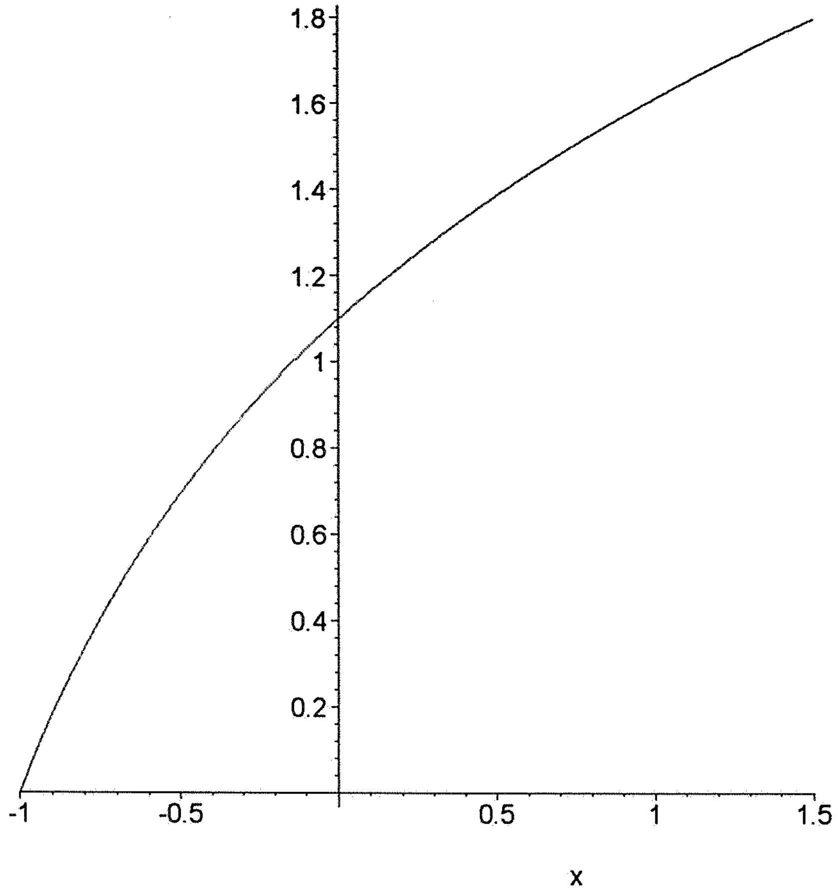
```
> # Plot of cos(x) with x-values between minus and plus two pi:
> plot(cos(x), x=-2*Pi..2*Pi);
```




```
> # Similarly plot of cos(2*x - Pi/4) with x-values between minus
  and plus two pi:
> plot(cos(2*x - Pi/4), x=-2*Pi..2*Pi);
```



```
> # Similarly for a simple (natural) log graph:
> plot(ln(2*x + 3), x=-1..1.5);
```




```
> # The Maple help file on such graphing is obtained using ?plot
  (no need for the ';' ending) and it has an extensive set of
  examples at its end.
> # More sophisticated plotting facilities are also available in
  Maple, to access them one needs to load the 'plots' package
  using the command 'with(plots);'
```