

MATHEMATICS 201-009-50

Precalculus
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Maple Introduction

Maple is what is called a computer algebra system. It can do everything the fanciest graphing calculator can do and so much more.

A Maple line is indicated by an input prompt `>` at the left hand margin. A Maple command is entered by typing it on an input line with a semicolon (`:`) at the end and pressing “Enter”.

Maple as Calculator

Basic arithmetic is done as expected, where `*` is used for multiplication, `^` for exponents, `sqrt` for square roots and `surd(x,n)` for $\sqrt[n]{x}$, n^{th} roots.

```
> (2+3)*4-3^2;
```

```
> 200.0/4;
```

```
> 4/6;
```

If a decimal number is used, then Maple will return a decimal answer to ten figure accuracy. If only integers are used, then Maple will give an exact answer. To obtain a numerical answer, we use the command `evalf()`. Use `%` for the last answer returned (this can save rewriting).

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

Maple will give you more accuracy if you tell it how many figures you want.

```
> evalf[100](sqrt(2));
```

Maple has all the standard functions built in. The trigonometric functions are as usual, except that they use radians. The exponential function with base e is called `exp`. Its inverse is `ln`. For other logarithms with base b , use `log[b]`. For the number π , use `Pi`.

```
> cos(Pi);
```

```
> log[2](8);
```

You can assign names to expressions using the `:=` symbol.

```
> a:=Pi/4;
```

```
> 3*a+2;
```

To erase from memory the names you use we have the `restart` command.

```
> restart;
```

Basic Algebra

The advantage of Maple is that we can work with algebraic expressions and do a certain number of operations on them such as simplify, factor, expand, etc. Let us look at some examples.

Simplification of expressions such as $\frac{x^2-x-6}{x+2}$ are done with the commands, `simplify` or `normal`.

```
> simplify( (x^2-x-6) / (x+2) );
```

```
> normal( (x^2-x-6) / (x+2) );
```

Note: this simplification is only valid when $x \neq -2$, so caution is advised when simplifying.

Factoring the expression $x^2 - 4$ and expanding $(x + 2)^3$:

```
> factor(x^2-4);
```

```
> expand((x+2)^3);
```

To solve equations, such as $x^2 - 3 = 0$, use the command `solve(equation, variable to solve for)`.

```
> solve(x^2-3=0, x);
```

If we wish to have decimal answers, then we use the **fsolve** command.

```
> fsolve(x^2-3=0, x);
```

Functions

Functions can be defined with **name := x → function**. For example $f(x) = x + \frac{1}{x}$ is defined as

```
> f:=x->x+1/x;
```

To evaluate a function at a given point, such as at $x = 2$, we have

```
> f(2);
```

or to simplify,

```
> simplify(f(x));
```

For function composition, we use “@”. For example, $(f \circ f)(x)$ is given by

```
> (f@f)(x);
```

For functions defined piece wise, we use the command `piecewise(region 1, rule on region 1, region 2, rule on region 2, ...)`. For example, the function $f(x) = \begin{cases} x^2 + 1 & x < 2 \\ 5 - x & x \geq 2 \end{cases}$ would be

entered as follows:

```
> f:=x->piecewise(x<2,x^2+1,x>=2,5-x);
```

```
> f(x);
```

Graphing

Maple can be of great help to see what the graph of a function looks like. The basic command for plotting graphs is given by **plot(function, domain)**. The interval for the domain has the form **x=a..b**. For example, let us sketch the graph of $f(x) = x^5 - 2x + 1$.

```
> f:=x->x^5-2*x+1;
```

```
> plot(f(x),x=-5..5);
```

Note that the range is rather large, so we can restrict it when needed.

```
> plot(f(x), x=-5..5, y=-2..4);
```

For functions which are discontinuous, it might be useful to add the option **discont=true**.

```
> f:=x->piecewise(x<2, x^2+1, x>=2, 5-x);
```

```
> plot(f(x), x=-3..6, y=-2..6, discont=true);
```

Note that Maple puts a dot on the point (2,3) to represent its inclusion (it corresponds to a full dot the way we do it in class).

To graph a relation, we have the command **implicitplot(equation, domain, range, options)** from the **plots** library (which must be loaded first). In the options you may want to ask Maple to use more points with **numpoints=1000**, for example, if the picture of the graph is not very good.

```
> with(plots):
```

```
> implicitplot( x^2+y^2=1, x=-3..3, y=-3..3);
```

To have more than one function on a graph, we use the **display** command from the **plots** library. For Maple to do a combination of things in one big step, we do a SHIFT-RETURN instead of an ordinary RETURN at the end of each command, except the last. For example, plotting the curve $f(x) = x^2$ along with the line $y = 2x - 1$:

```
> with(plots):
```

```
  a:=plot(x^2,x=-3..3,color=blue): ← Note: use a “:” here instead of “;”.
```

```
  b:=plot(2*x-1,x=-3..3,color=red):
```

```
  display(a,b);
```