MATHEMATICS 201-105-RE
Linear Algebra
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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".

Basic arithmetic is done as expected, where ***** is used for multiplication, **^** for exponents, and **sqrt** for square roots. If a decimal number is used, then Maple will return a decimal answer to ten figure accuracy.

```
> (2+3)*4-3^2;
> 2/4;
> 2.0/4;
```

If only integers are used, then Maple will give an exact answer. To obtain the a numerical answer, we use the command **evalf( )** .

```
> evalf( sqrt(2) );
```

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]**.

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

You can give names to expressions using the **:=** symbol.

```
> a:=Pi/4;
> 3*a;
> sin(a);
```

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

```
> restart;
```

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.

Simplify the expression $\frac{x^2 - x - 6}{x + 2}$.

```
> simplify( (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 $x^2 - 4$:

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

Expanding $(x+2)^3$:

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

We can also solve equations with the command **solve(*equation*, *variable to solve for*)**.

Solving the equation $x^2-3=0$:

> 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 are defined as follows: ***name* := x → *function***

For example, suppose we have the function $f(x)=x+\frac{1}{x}$.

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

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

> f(2);

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(expression, x=a..b, y=c..d)

Function to graph	Domain to be plotted	Range to be plotted (optional)

For example, let us sketch the graph of $f(x)=x^5-2x+1$.

> plot(x^5-2*x+1,x=-5..5);

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

> plot(x^5-2*x+1,x=-5..5,y=-5..5);

To graph a relation, we have the command

implicitplot(equation, domain, range, numpoints = n)

Optional, but you may need it to obtain an accurate curve. By default, *n* = 1000.

from the "plots" package. The first thing to do is to load the package.

> with(plots):

Let us plot the circle $x^2+y^2=1$.

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

To graph more then one function on a graph, we use the display command from the "plots" package. To have more than one step at a time, we do a SHIFT-RETURN instead of an ordinary RETURN at the end of the line. For example, suppose we want to plot the curve $f(x)=x^2$ along with the line $y=2x-1$.

```
> with(plots):
  a:=plot(x^2,x=-3..3):
  b:=plot(2*x-1,x=-3..3):
  display(a,b);
```

← Note: use a " : " here instead of " ; ".