MAT 155   Project I   Spring 2014
                  Introduction to Maple

> BYUNG DO PARK

Saving this file:
Before you begin working you should save this file as **yourname1.mws** by selecting "File" on the far left of the top bar of Maple V and choosing "**Save As**". A window will appear and you will fill in the file name. You should regularly save this file using the "Save As". You should also save the file with a second name **yourname1b.mws** using the "Save As" **so that you have a backup** in case your file is damaged. The computer will tell you that the file already exists and you will click on "Yes" that you agree to overwrite it. If you just use the "Save" instead of the "Save As" then the file will be saved with whichever name is on the top bar of this window. Be careful to check that you only have one file window open or you may have different files saving on top of each other.

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Problem 1. Operations
Recall that multiplication, addition, division, etc are all operations. To use Maple as a calculator, you just type the formula you are interested, then type a semicolin (;) and then hit enter. Maple obeys the order of operations so it will do exponents first, then multimplication and division, then addition and subtraction. If you want it to do addition first, you must put it in parenthesis.

Click on the following lines and hit "Enter" to see examples:
> 1+2*3;

                                        7   **(1)**
> (1+2)*3;
> 6−4/2;
> (6−4)/2;
> 3^2;
> 3*2^2;

Now type compute the following using maple yourself. You must type your command on a line beginning with a [> symbol which is called a prompt. Don't forget the ; or Maple will write : "Warning, premature end of input".

a)   (3+4) cubed.
> (3+4)^2;

                                        49   **(2)**

b)   1+15
       7+1   (the answer is 16/8=2 be careful).
> (1+15)/(7+1);

                                        2   **(3)**

c) 5(3+2)   (don't forget the symbol for multimplication)

```
> 5*(3+2);
```
$$25 \tag{4}$$

It is time to save your work. Go to the top of the file using the up arrow key and review how to do this. Remember you must save it twice.

Problem 2: Decimal Expansions

Maple always tries to give an exact answer but if there is no exact answer then it just displays a fraction or a square root. If you want a decimal expansion, use the **evalf** command. Hit enter to see how it works:

```
> 1/2;
```
$$\frac{1}{2} \tag{5}$$

```
> evalf(1/2);
```
$$0.5000000000 \tag{6}$$

```
> 2^(1/2);
```
$$\sqrt{2} \tag{7}$$

Recall that the square root of 2 is irrational. So the decimal expansion continues forever but Maple only gives the first ten decimal places.

$$\sqrt{2}$$

```
> evalf( 2^(1/2));
```
$$1.414213562 \tag{8}$$

Remember that there is no real square root of (-1). There is an imaginary square root for (-1) which is called i or I.

```
> (-1)^(1/2);
```
$$I \tag{9}$$

In Calculus I we do not use imaginary or complex numbers. So be careful if you get an *I* in an answer.

a) Find the decimal expansion for 1/3.

```
> evalf(1/3);
```
$$0.3333333333 \tag{10}$$

b) Find the cube root of 8.

```
> evalf(8^(1/3));
```
$$2.000000000 \tag{11}$$

c) Find the cube root of 2.

```
> evalf((2)^(1/3));
```
$$1.259921050 \tag{12}$$

 It is time to save your work. Go to the top of the file using the up arrow key and review how to do this. Remember you must save it twice.

Problem 3: Functions

A function is a mapping from a domain to a range. For example f(x)=x^2 maps real numbers to real

numbers bigger than or equal to 0. Mathematicians write:

f: (-infinity, infinity) -> [0, infinity)   and   f : x   -> x^2

So f takes -1 to 1, -2 to 4, 3 to 9 and so on. To define a function in maple we use a similar notation. To make the right arrow we use a dash (near the letter p on the keyboard) and a greater than sign (>). Hit enter on the following line:

```
> f:= x -> x^2;
```

$$x \rightarrow x^2 \tag{13}$$

Note that there is an equals sign in Maple's notation! In Maple := is always used to define things.
Now to evaluate a function, you write:

```
> f(5);
```

$$25 \tag{14}$$

```
> f(-3);
```

$$9 \tag{15}$$

a) Define a function g which maps x to x/3.

```
> g:=x->x^(1/3);
```

$$x \rightarrow x^{1/3} \tag{16}$$

b) Evaluate g at 7 and at 8.

```
> g(7);
```

$$7^{1/3} \tag{17}$$

```
> evalf(g(8));
```

$$2.000000000 \tag{18}$$

Maple has already defined some functions. For example sqrt takes a number to its square root:

```
> sqrt(4);
```

c) Ask Maple to find the square roots of 9 and of -9.

```
> sqrt(9);
```

$$3 \tag{19}$$

```
> sqrt(-9);
```

$$3\,I \tag{20}$$

d) In Calculus we often create new functions from old functions. For example, we might want to take a number and first map it using f and then map it using g. That is we take x and square it using f to get x^2, and then take x^2 and act g on it to get g(x^2) which is:

```
> g(x^2);
```

This new function is written as g(f(x)).

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

If you want to compute g first and then f you use f(g(x)). Compute this by hand and then check your answer using Maple.

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

$$x^{2/3} \tag{21}$$

Problem 4: Trigonometry

Recall the trig functions sine and cosine. If you do not already know their definitions you should not be taking calculus! Speak to your teacher today!

You should recall that sin (30 degrees)=1/2 , sin (60 degrees)= sqrt(3)/2, sin (90 degrees)=1 however *in calculus we do not measure angles using degrees*!!!

```
> sin(30);
```
$$\sin(30) \tag{22}$$

```
> evalf(sin(30));
```
$$-0.9880316241 \tag{23}$$

As you see by hitting the above lines that Maple does not compute sin(30) and that even the decimal expansion of sin(30) has nothing to do with .5000000000, in fact it is negative. This is because in calculus *we use radians to measure angles.*

Ask your teacher to explain radians to you if you do not know what they are. There is a very nice picture with a unit circle that can be drawn on the board. This picture also helps you remember when sine and cosine are positive and negative. You may also read Appendix A.3 in the text..

For a quick conversion from radians to degrees just remember that the circumference of a circle of radius 1 in 2Pi and the degrees to go all the way around is 360. So 360 degrees= 2Pi. So 90 degrees= 90 (2Pi/360) and we get:

```
> 90*(2*Pi/360);
```
$$\frac{1}{2}\pi \tag{24}$$

Which is Pi/2 radians. So sin (90 degrees)=sin(Pi/2) and we type:

```
> sin(Pi/2);
```
$$1 \tag{25}$$

a) Compute the radians for 60 degrees and then find sin(60 degrees).

```
> 60*(Pi/180);
```
$$\frac{1}{3}\pi \tag{26}$$

```
> sin(Pi/3);
```
$$\frac{1}{2}\sqrt{3} \tag{27}$$

b) Compute the cosine of 180 degrees.

```
> cos(Pi);
```
$$-1 \tag{28}$$

c) Find the tangent of Pi/4. Compare it with sin(Pi/4) and cos(Pi/4).

```
> tan(Pi/4);
```
$$1 \tag{29}$$

```
> cos(Pi/4);
```
$$\frac{1}{2}\sqrt{2} \tag{30}$$

```
> sin(Pi/4);
```

$$\frac{1}{2}\sqrt{2}$$
(31)

d) Notice that cos(Pi/2) is 0 so *tan(Pi/2) is not defined.* See what Maple gives you:

```
> tan(Pi/2);
Error, (in tan) numeric exception: division by zero
```

It should say "*Error, (in tan) singularity encountered.*" Maple always tries to explain what is wrong with your command if it asks it to do something impossible or it is not clear.

It is time to save your work. Remember you must save it twice.

Exploration: Every project ends with exploration. Before starting the exploration you should make sure that you have completed all of the problems. Once you have completed them you can make up similar problems or do recommended exploration problems. If you miss a lab, you must catch up on the previous labs problems to learn all the commands and ideas that you missed. The exploration need not have been completed to continue with the next project. Your professor may, however, require you to complete the exploration for grading purposes.

Recommended exploration problems:
To do this work you need only hit enter at the bottom of the lab to create more prompts [>.

A) Practice using the unit circle to find sin(-Pi), sin(-Pi/2), sin(0), sin(Pi/2), sin(Pi), sin(3Pi/2), sin(2Pi), and check your answers with Maple. Then use the unit circle to figure out where tangent is undefined and check your answer with Maple.

B) Define a function f(x)=1-x^2. Use Maple to study f(sin(x)). Then define a function g(x)=x^2. Use Maple to study g(cos(x)). Compare f(sin(x)) with g(cos(x)).
Remember to save your exploration problems regularly.
Solution to B)

```
> f:=x->1-x^2;
```
$$f := x \rightarrow 1 - x^2$$
(32)

```
> g:=x->x^2;
```
$$g := x \rightarrow x^2$$
(33)

```
> g(cos(x));
```
$$\cos(x)^2$$
(34)

```
> f(sin(x));
```
$$1 - \sin(x)^2$$
(35)

```
> g(cos(x));
```
$$\cos(x)^2$$
(36)

>

Hint for A) Recall that cos(theta) , sin(theta) are defined by the x- and y-coordinate, respectively, of the point P on the unit circle whereas the angle between the positive x-direction and OP is theta. So you should draw a unit circle on a sheet of paper and figure out what are y-coordinates corresponding to given angles -Pi, -Pi/2, 0, Pi/2, Pi, 3Pi/2, 2Pi. This problem is asking to figure out those y-coordinates using MAPLE. For the second part, recall that tan(theta)=sin(theta)/cos(theta) whereas cos(theta) vanishes when your angle gives x coordinate of the point on the unit circle vanishing. This is then asking you to use MAPLE to see what happens if evaluate those angles for tangent.

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