Maple Lab
In Class Exercises

1. Practice with Arithmetic

(1) PRACTICE SESSION: Type in the following, and note what comes out.

```
? sin
? numer
2+4;
134^39;
3/5 + 5/9 + 7/12;
sqrt(24);
4*(3+Pi);
sin(5*Pi/3);
exp(x);
```

(2) SUMMARY: We can perform exact arithmetic in Maple. We've looked at some of the built in functions.

(3) PRACTICE SESSION: Type in the following, and note what comes out.

```
seq(k^2,k=1..100);
ifactor(31722722304);
evalf(3/5 + 5/9 + 7/12);
evalf(Pi,3);
evalf(Pi,100);
```

(4) SUMMARY: We looked at `seq` and `evalf`

(5) PRACTICE SESSION: Type in the following, and note what comes out.

```
joe:=32;
sqrt(joe);
sqrt(32.0);
result:=seq(sqrt(k),k=1..10);
evalf(result);
```

(6) SPECIAL TOPIC: Clearing your variables and re-setting Maple.

Here's an example of first assigning a number to a variable, then clearing it:

```
x:=65;
w:=x^2-4*x+7;
x:='x';
w:=x^2-4*x+7;
```

To clear Maple's memory completely, type `restart` For example,

```
p:=4; h:=Pi;
p; x; h;
restart;
p; x; h;
```

2. Practice with Algebra

(1) Problem: Save the expression $3x^2 + 8$ into a variable W, then substitute $x = 4$ into the expression.

```
W:=3*x^2+8;
subs(x=4,W);
```

Substitute the expression $4u - 5$ in for x.

```
subs(x=4*u-5,W);
```

Do multiple substitutions or more complex substitutions:

```
U=(2/5)*x^2+3*y;
subs(x=3, y=4, U);
U:=sin(x)/sqrt(1-sin(x));
subs(sin(x)=y,U);
```

(2) There is a difference between an *equation* and an *assignment*. The `:=` notation is to assign the left hand side to the variable on the right hand side. The following will give you an error:

```
A+B:=6;
```

But we can assign the equation $A + B = 6$ into a third variable:

```
eqn1:=A+B=6;
```

and make substitutions:

```
subs(A=3,B=2,eqn1);
```

(3) We can *expand*, *factor*, and *simplify* algebraic expressions:

```
H:=2*(x-2)*(2*x^2+5*x+2)*(x+4);
factor(H);
A := (x^3-7*x^2+15*x-9)/(x^2+4*x+4)
factor(A);
factor(3*x^4-2*x^3+22*x^2-18*x-45);
ww:=x^(1/2)-x^(3/2);
factor(ww);
h:=7/(x+2)+(3*x/(x+2)^2);
simplify(h);
h:=sin(3*t)-sin(7*t);
simplify(h);
```

3. Functions

In Maple, there is a difference between a *function* and an *expression*. Here is how we define a function:

```
f:=x->sin(x)/x;
f(3);
f(x+h);
```

We can have Maple compute a derivative by using the definition:

```
f:=x->sin(a*x);
G:=(f(x+h)-f(x))/h;
limit(G,h=zero);
```

4. Calculus

The main computations in Calculus are the limit, the derivative, and the integral. If you're continuing on from the previous section, type `restart;` before going on.

(1) Compute $\lim_{x\to 0} \frac{\sin(x)}{x}$

```
A:=sin(x)/x;
limit(A,x=0);
```

Compute $\lim_{x\to 0} \frac{1}{x}$

```
limit(1/x,x=0);
```

We can compute multivariate limits:

```
A:=(x^2-y^2)/(x^2+y^2);
limit(A,{x=0,y=0});
```

Or even limits that should probably not exist:

```
limit(sin(1/x),x=0);
limit(a*x,x=infinity);
```

(2) The basic derivative (using an *expression*):

```
A:=(x^2-y^2)/(x^2+y^2);
diff(A,x);
diff(A,y);
```

(3) Basic integration:

```
int(sin(x),x=0..3*Pi);
int(1/x^2,x=1..infinity);
int(x/(x^3-1),x);
int(exp(-x^2)*ln(x),x);
```

"Inert" integration: Will give a numerical approximation

```
L:=Int(exp(-x^2)*ln(x),x=1..3);
evalf(L);
```

We can compute improper integrals:

```
int(exp(-t)*t^2,t=0..infinity);
```

5. Graphing

(1) A basic plot: Plot $3x^2 - 8, -5 \leq x \leq 5$

```
plot(3*x^2-8,x=-5..5);
plot(3*x^2-8,x=-5..5,y=-3..10);
```

Be careful about the window size!

```
plot(x^3+1-exp(x),x=-8..8);
plot(x^3+1-exp(x),x=-8..8,y=-5..15);
```

(2) Plot two curves together, and add some color. The second command is useful when the printer does not do color:

```
plot( [cos(x),x^2],x=-4..4,color=[blue,black]);
plot( [cos(x),x^2],x=-4..4,color=[blue,black],linestyle=[1,4]);
```

(3) Plot points and line segments:

```
plot([[3,2],[-2,3],[2,-1]],style=point,color=blue,symbol=circle);
plot([[3,2],[-2,3],[2,-1]],style=line, color=red);
```

(4) Overlay several graphs on top of each other: Note the use of the colon

```
with(plots):
Fig1:=plot([3*x+5,9-x^2],x=-3..5,color=[green,red]):
Fig2:=plot([[-1,8],[4,-7]],style=point,color=blue,symbol=circle):
display({Fig1,Fig2});
```

The last line could also read: `display([Fig1,Fig2]);`

(5) Parametric plots. Suppose

$$x(t) = \cos(3t), \quad y(t) = \sin(t + sin(5t))$$

then we can plot the curve as:

```
x:=cos(3*t);
y:=sin(t+sin(5*t));
plot( [x,y,t=1..10] );
```