Maple Commands for Chapter 14 (Stewart)

1. Graph the function

Graph $z = f(x, y)$. In this example, $z = \sqrt{9 - x^2 - y^2}$

```
f:=(x,y)->sqrt(9-x^2-y^2);
plot3d(f(x,y),x=-3..3,y=-3..3);
```

Note that when you click your mouse on the graph, you can spin it around. You can also change how the axes look, put on a legend, change the coloring, etc. Experiment with the menu options (with the black box around the figure- otherwise, you get the regular menu options).

2. Plot the level curves

Plot the level curves (also called contours) of the function $z = f(x, y)$. The Maple command is `contourplot`

```
with(plots):
contourplot(sin(x*y),x=-3..3,y=-3..3);
```

3. Multiple Limits.

EXAMPLE: Does $\lim_{(x,y)\to(0,0)} \frac{x^2 - y^2}{x^2 + y^2}$ exist?

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

EXAMPLE: Use a graph of the function to determine if the following limit exists:

$$\lim_{(x,y)\to(0,0)} \frac{2x^2 + 3xy + 4y^2}{3x^2 + 5y^2}$$

```
f:=(x,y)->(2*x^2+3*x*y+4*y^2)/(3*x^2+5*y^2);
plot3d(f(x,y),x=-1..1,y=-1..1);
```

4. Partial Derivatives:

Example: If $f(x, y, z) = xe^{xy}\ln(z)$, compute all first partial derivatives and all second partials involving x and z.

```
f:=(x,y,z)->x*exp(x*y)*ln(z);
fx:=diff(f(x,y,z),x);  #This is the partial of f w/r to x
fy:=diff(f(x,y,z),y);
fz:=diff(f(x,y,z),z);
fxx:=diff(fx,x);
fxz:=diff(fx,z);
fzx:=diff(fz,x);
fzz:=diff(fz,z);
```

5. Tangent Planes

Find the expression for the tangent plane, and plot the plane together with the function.

EXAMPLE: If $f(x, y) = xe^{xy}$, plot $z = f(x, y)$ together with the tangent plane to f at $x = 1, y = 1$.

First, rewrite the equation of the tangent plane:

$$z = z_0 + f_x(x_0, y_0)(x - x_0) + f_y(x_0, y_0)(y - y_0)$$

Using Maple:

```
f:=(x,y)->x*exp(x*y);
fx:=diff(f(x,y),x);
fy:=diff(f(x,y),y);
fx1:=subs({x=1,y=1},fx);
fy1:=subs({x=1,y=1},fy);
P:=f(1,1)+fx1*(x-1)+fy1*(y-1);
plot3d({f(x,y),P},x=-1..3,y=-1..3,view=0..5,axes='boxed');
```

6. The Chain Rule

(See Example 5, p. 921 of Stewart's Calc)

If $u = x^4y + y^2z^3$, and $x = rse^t$, $y = rs^2e^{-t}$, and $z = r^2s\sin(t)$, find the value of $\dfrac{\partial u}{\partial s}$ when $r = 2, s = 1, t = 0$.

In Maple:

```
x:=r*s*exp(t);
y:=r*s^2*exp(-t);
z:=r^2*s*sin(t);
u:=x^4*y+y^2*z^3;
h:=diff(u,s);
h1:=subs({r=2,s=1,t=0},h);
evalf(h1);
```

7. Implicit Differentiation:

If $F(x, y) = 0$, then $\frac{dy}{dx} = \frac{-F_x}{F_y}$

EXAMPLE: Find y' if $x^3 + y^3 = 6xy$.

In Maple:

```
F:=x^3+y^3-6*x*y;
dydx:=diff(F,x)/diff(F,y);
```

8. The Gradient

Compute the Gradient, $\nabla f = [f_x, f_y, f_z]$

In Maple, if $f(x, y, z) = 3x^2 + 2yz$, then the gradient is:

```
with(linalg):
grad(3*x^2+2*y*z, vector([x,y,z]));
```

9. Contours and Gradients

Plot the contours of $f(x, y) = x^2 - y^2$, together with some gradient vectors (See Figure 13, pg. 936)

```
with(plots):
A:=contourplot(x^2-y^2,x=-4..4,y=-4..4):
B:=gradplot(x^2-y^2,x=-4..4,y=-4..4,grid=[6,6],arrows='slim'):
display({A,B});
```