Mathematics 41, section 1 – Multivariable Calculus
Different Plotting Functions for $f(x, y)$ in Maple
September 29, 1999

Background

As we discussed in class on Monday, there are a number of ways to generate graphics to represent the behavior of functions $f(x, y)$ on domains $D \subset \mathbf{R}^2$. In this document, we summarize the Maple commands for producing each. Three of these (namely `densityplot`, `contourplot`, and `contourplot3d`) are in the `plots` package. So it is best to start any worksheet where you want to produce plots by loading that package with the command

```
with(plots):
```

1. Density Plots

The command for producing density plots is called `densityplot`. The format is

```
densityplot(expression,xrange,yrange,options);
```

For example, try the command

```
densityplot(x^2 - y^2, x=-3..3,y=-3..3);
```

You will see a density plot, shown together with a default 25 × 25 grid on the rectangle $[-3, 3] \times [-3, 3]$.

Important Note: This command in Maple actually has a "known bug"!! The light areas are supposed to represent *larger function values*, and the dark areas are supposed to represent *smaller function values*. If you look carefully at your plot, you will see that the picture is "backwards" from what you would expect according to this information. The function should larger positive values at points on the x-axis and smaller, more negative values at points on the y-axis. But the lightest parts of the density plot are near $y = \pm 3$. What is wrong is that the x- and y-axis labels in the plot are reversed. (D'oh!!) You will need to take that into account in looking at Maple density plots (until this is fixed in a future version).

To change the default 25×25 grid to an $m \times n$ grid, you can include an option `grid=[m,n]`. Sometimes it is helpful not to see the grid lines. You can do that with an option `style = PATCHNOGRID`. Try the modified command

```
densityplot(x^2 - y^2, x=-3..3,y=-3..3, grid=[50,50],style=PATCHNOGRID);
```

to see the effects of these options.

Another Important Note: Density plots with very "fine" grids (big values for m, n) take up a lot of space. If you have multiple density plots in a worksheet, you may want to save the worksheet with the output removed (use the Remove Output option from the bottom of the Edit pulldown menu).

2. Contour Plots

Maple actually has two plotting functions for contours of $f(x,y)$. Recall that, given a real number c, the contour of $f: D \to \mathbf{R}$ for the value c is the set

$$\{(x,y) \in D : f(x,y) = c\}$$

The `contourplot` command produces a 2D contour plot. The basic format is

```
contourplot(expression,xrange,yrange,options);
```

For example, try

```
contourplot(x^2 - y^2,x=-3..3,y=-3..3);
```

and see how this matches up with your density plot. There are a number of options available with this command, including ways to specify the numbers of contours to be drawn, the c-values, and so forth. All this information and example commands illustrating the various things you can do are available from Maple's *on-line Help*. Type in the command `?contourplot` (or use the Help pulldown menu) to see it.

There is a second command called `contourplot3d` that plots the contours "raised to the appropriate planes $z = c$". In other words, the output of `contourplot3d` shows a collection of horizontal slices of the set

$$\{(x,y,z) \in \mathbf{R}^3 : z = f(x,y)\}$$

The output from a `contourplot3d` command is a 3D graph which can be rotated and manipulated in the same way that the `spacecurve` plots we saw in Lab 1 can. For example, try experimenting with:

```
contourplot3d(x^2-y^2,x=-3..3,y=-3..3);
```

3. Plotting of graphs: $z = f(x,y)$

The command for 3D plotting is called `plot3d` (naturally enough!) Its format is similar to, but not exactly the same as the format of `plot`. To draw a graph with `plot3d`, you use a command of the format:

```
plot3d(function,xrange,yrange,options);
```

The `function` is the function $f(x,y)$, entered in the usual Maple syntax for expressions. The `xrange` and `yrange` specify a rectangular box in the plane that the plot will be constructed over; the `options` can be used to specify how the plot is drawn. Look at the online help for `plot3d[options]` if you want to see what things are possible. Most of the options can also be invoked from the 3D graphics output via the pop-up menu from the graphics output, or the style is often a very effective way to visualize the shape of a surface. (It also shows contours, "lifted to the appropriate plane $z = c$", as curves on the surface $z = f(x,y)$.)

For example, try

```
plot3d(-x^4+2*x^2-x/2-y^2-1,x=-2..2,y=-2..2);
```

to plot the surface

$$z = -x^4 + 2x^2 - x/2 - y^2 - 1.$$

One very nice feature of Maple 3D graphics is that you can change viewpoint, add axes, etc. using the mouse and the toolbar options in the 3D graphics window. The method is the same as that for the `spacecurve` graphs from Lab 1.

Assignment

Exercises 1, 2, 3 from Discussion 15 in the Damiano/Freije Collaborative Learning Workbook. Due: Monday, October 4.