Ma3 For Windows

Ma3 is a software package which was written to:

1: Draw surfaces, z=f(x,y), in Rectangular coordinates
2: Draw surfaces, z=f(r,theta) in cylindrical coordinates
3: Draw space curves, x(t), y(t), z(t).
4: Plot 2-parameter surfaces, x(u,v), y(u,v) z(u,v)

Ma3 is on the networks of the computer labs. When you have logged on to a computer in a computer lab, Click on the Icon Math-Business Applications. A new window of Icons will appear. Click on True-Ware. Click on the Icon for Wma3.exe . You will see a Main Menu showing the selections that are listed above.

The following example will illustrate the use of Ma3. We will draw the graphs of some functions in rectangular coordinates.

At the Main Menu, click on the button labeled 1. to **Draw surfaces in Rectangular Coordinates**. You will see a graphics screen with a set of axes. Both the x and y axes are currently set to go from -3 to 3, and the range for the z-axis is from -10 to 10. At the top of the screen, you will see a menu of selections that we will use to set up our graphs. Each of these selections are explained briefly under **Help**. It's a good idea to read through the **Help** file to see what functions are available and how to enter them.

To begin, click on **Function.** A dialogue box will appear for you to enter your function. Type in x^2-y^2. This is the quadratic function $z = x^2 - y^2$. Press the Enter key. Click on **Draw** and the graph of the function will be drawn from x = -3 to x = 3. That's all there is to it. Now we'll look at some of the other features you will need.

On the right of the graphics window, there is a compass with four arrows. Click on one of these arrows to rotate the surface to a different position. By repeating this process, you can move the graph around to view it from different angles. To change to a specific location, click on View in the main menu and set your angles for phi and theta. These are the spherical coordinates for the viewing position or eye of the viewer. Theta is the angle from the positive x-axis, and Phi is the angle from the positive z-axis. If Phi=0, you are looking straight down onto the xy plane.

Click on Edit and then **Curves** . The default value is 15 curves in both the x and y direction. This means that the x and y intervals are divided into 15 subintervals and the function is being evaluated at 15 points in both the x and y direction for a total of 225 points. These form the vertices of a quadrilateral which is then drawn to represent the surface. To plot more points, or curves to refine the graph, increase the number of curves from 15 to say 45, and draw the surface again to see the difference.

Click on File and then **List Function Values** . You will see a new dialogue box, which gives the list of numerical values of the function you just plotted .

Click on **Axes**. With this dialogue window, change Minx to -4. Then press the Tab key to move the cursor to Maxx and change that to 4. Press Tab again and set Miny to -5, Tab again and set Maxy to 5. Leave the Minz and Maxz where they are. Press Enter, and the graphics screen is erased and refreshed with your new entries. Now Click on Draw again and see the saddle drawn on your new screen.

Click on **Edit|Domain** . The default values are from -3 to 3. As you did with Axes, change Minx to -4, Maxx to 4, Miny to -5 and Maxy to 5. Press Enter and Draw the surface again. You will see some jagged edges, because the graphing window is not large enough. Go back to Axes and set Minz to -25 and Maxz to 15 and Draw again.

Click on Edit and then **Graph Title** . Type in your name and press enter. The title will appear at the top of the graphics box.

Editing Your Graph: When you have drawn a graph, you can save it as a bitmap, gif or jpeg. Click on File|Save Graph. If you want to annotate or add something to your graph, you can load it into MSPaint, a graphics editor. To do this, click on Edit and then **Graph** . This will launch the program MSPaint. Once you have opened up MSPaint, click on **File|Open** and enter the name of the graph you saved from Ma2. You can now use MSPaint to edit your graph and annotate some curves by inserting some text, like the word *Saddle* next to your graph. When finished, click on **Save** to save your graph and then **Exit** . If you want, you can now reload your edited graph back into Ma3 by clicking on File|Open.

Take some time to experiment with some of the other features of Ma2, like changing the graphing colors, background colors, opening and saving graphs, and printing.

When you type in a function to be drawn, it must be typed in with the proper symbols and syntax. Click on **Help** and read the information about how to enter functions. It tells you how to save graphs as bitmaps, jpegs or gifs to insert in another document, or copy a graph to the clipboard. Also, read about some of the other selections and then try them out to become familiar with the software.

There is a theory developed for finding local maxima and minima on a surface. It begins with finding all points where the partial derivatives equal zero. For now, we will just plot some surfaces and make some observations about how functions of two variables can have infinitely many local extrema.

Click on Samples to open the window of Sample functions.

a) Select the radio button for the function $z = (2x^2 + 3y^2)e^{1-x^2-y^2}$. It looks like {(2*x^2+3*y^2)*Exp(1-x^2-y^2)}. Then Click on Draw. The function will be displayed at the bottom of the screen. Play around with this surface until you get the projection you like. This "volcanic" surface has some extrema , some are maxima, some are minima, and some are what we call saddles, where the tangent plane is horizontal, but it is not an extremum.

b) Select the radio button for the surface $z = 9-(trunc(x))^2-(trunc(y))^2$. Try -3<x,y<3. The Trunc function returns an integer. See the Help pages for more information about different functions. Notice how this function has extrema on plateaus.

c) Select the surface $z = \cos\sqrt{x^2+y^2}$. { Cos(sqrt(x^2+y^2))}.
Try -12<x,y<12 with high resolution. This is called the sombrero surface.

Cylindrical Coordinates: Click on File|Exit to return to the Main Menu and select 2. to draw surfaces in Cylindrical Coordinates.

a) Take the previous function $z = \cos\sqrt{x^2+y^2}$ and rewrite it in cylindrical coordinates.

Click on Function and enter this function, then Draw. Click on Edit|Domain and set r to go from 0 to 11, or something like that. You may also want to improve the resolution with more curves. This is the Sombrero again, and it looks better in cylindrical. Note the circles of extrema.

b) Now lets jazz up the sombrero with the “skewed” sombrero, by changing the function to $z = \cos(r)\cos(t)$. This is a complex surface of windings with many interesting features.

c) Experiment with other surfaces in cylindrical coordinates, especially those with symmetry with respect to the z-axis. For example, the function $z = x^2+y^2$, when converted to cylindrical is $z = r^2$, so enter this and draw it.

2-Parameters Surfaces: Let’s exit back to the Main Menu and select 4. to draw 2-parameter surfaces. With 2 parameters, u and v, it is possible to draw surfaces other than those that are just graphs of functions. These kinds of surfaces were first introduced by Gauss, and include all the quadric surfaces as special cases.

a) Again, click on Samples to see some built-in equations for two-parameter surfaces. Try the torus first. For axes, try -3<x,y<3 and -2<z<2. Now see if you can change the domain for u and v to open up the torus so you also see inside. To do this, click on Edit|Domain, and set 1<u<6, and redraw the surface. Then again in Edit|Domain, set 1<v<6 to open up the torus some more. This illustrates how the domain is creating the surface.

b) Now select the Spiral ramp or Helicoil. Again, rotate this around until you get the desired projection. Notice how this surface spirals over itself, representing a multivalued function. What’s more difficult to understand is that this surface extends indefinitely in the u and v direction if you were to let u and v go from -∞ to ∞. Yet it manages to twist around itself indefinitely in the z-direction.

c) Now click on Functions and just change the Z from Z=u to Z=v and draw the result. Compare this with the equations for a cone on your sheet, a totally different surface.

d) If you have time, try some other surfaces , or modify one of them by changing u or v to 2u or 3v, or make up your own and see what you get.

A NOTE ON SAVING GRAPHS:

Once you’ve drawn a graph, you can Click on File|Save Graph. You will be asked to choose a name, like a:\mygraph.bmp. It will be saved as a bitmap. You can also save it as a .jpg or .gif . You can then insert it in another application like a Word document. If you Click on Edit|Copy Graph, that part of the graph inside the rectangle will be saved to the clipboard. You can then paste the graph into another application, or use Microsft Paint to edit it to add annotations or something else.