Lab 1: Graphical Solutions to 1st Order ODEs

Log on! Next, launch **Matlab**. The gears will start cranking, a logo and 3D graph will show up and eventually a window will open with the Matlab prompt. (It is >>). Now you are ready to go!

Type **dfield7** in the Command window and hit return.

A dialog box opens with lots of little boxes all filled in; ignore them and click on the **Proceed** button. You will see a graph with a direction field entitled $x' = x^2 - t$.

Now put the cursor on the point (2,1) and click. Now you know what the solution to the ODE $x' = x^2 - t$ with initial condition $x(2) = 1$ looks like.

Click somewhere else on the graph (that is, try another initial condition). Fool around a bit. Convince yourself that **solution curves do not cross**. (Why not?) If the picture gets crowded you can erase the picture by going to the **Edit** menu.

Problems

1. Let $y(t)$ be the solution curve to ODE $y' = sin(y + t)$ with initial condition $y(0) = 0$. What is $y(5)$? A ballpark estimate is good enough.

   Answer:_______________

   To do this problem you will have to click on the dialog box and change the equation!

2. Let $y(t)$ be the solution to the ODE $y' = sin(y+t)$ with initial condition $y(20) = 0$. What is $y(25)$? A ballpark estimate is good enough.

   Answer:_______________

   To do this problem you will have to click on the dialog box and change the minimum and maximum value of t.

3. Let $y(x)$ be the solution to the ODE $y' = sin(xy)$ with initial condition $y(0) = 0.1$. What is $y(2)$? A ballpark estimate is good enough.

   Answer:_______________

To do this problem you will have to click on the dialog box and change the equation and also change the name of the independent variable. Speaking of ballpark: I threw you a curve ball. Did you get an error message? Well, xy is written as x*y in Matlab. Try again!

4. Let $x(t)$ be the solution curve to the ODE $x' = (x^2 - 1)sin(xt)$.

   (a) If the initial condition is $x(0) = 1.01$ what is $x(2)$? $x(-2)$?
   By the way, x^2 is typed xˆ2 so you would enter
   x´ =(xˆ2-1)*sin(x*t).

   Answer:_______________

   (b) Repeat part a) but with $x(0) = 1.001$.

   Answer:_______________

   (c) Repeat part a) but with $x(0) = 1.00001$.

   Answer:_______________

   (d) Repeat part a) but with $x(0) = 1$.

   Answer:_______________

   (e) Repeat part a) but with $x(0) = 0.99$.

   Answer:_______________

How do you do these problems? You really cannot position the cursor on the graph to 5 decimal place accuracy even if you are steady handed. However, if you go to the **Options** menu and choose **Keyboard input** you can enter the initial condition accurately. Of course, you must also choose appropriate ranges for your variables.

In some problems it doesn't make too much difference in the final answer if your hand shakes a bit. In others it does. Can you look at the direction field and tell—in advance—which questions you can answer confidently and which are iffy?

5. Let $y(x)$ be the solution to the ODE $y' = y^2 cos(xy)$ with initial condition $y(0) = 1.217$. To 3 decimal place accuracy what is $y(1)$?

   Answer:______________

   To do this problem you will have to left click on the **Edit** menu and choose **Zoom in**; then use the mouse with the left button depressed to draw a rectangle you want to enlarge. You can repeat the procedure on the new graph if you need to.

If you have time, you can experiment with some of the other buttons and settings. For example, you can write some text on the graph or plot the direction field with arrows or remove the lines. You can also change the numerical method used; we will study different numerical methods in class, and in Lab 2.

You are done with this lab. If you need to solve a first order ODE quickly you can do it! What about higher order ODEs? Systems? Stay tuned!