Math 2208: Ordinary Differential Equations

Lecture 7 Worksheet

Spring 2020 **Subhadip Chowdhury** **Feb 12**

Title: ODE45

Summary: We will learn how to use a powerful Octave/Matlab algorithm called `ODE45` to solve ODEs numerically.

§A. Using Octave numerical methods

Last week we learned the forward Euler method algorithm to approximate solutions to an IVP in class and in homework. The method demonstrates the idea behind numerical methods, but it is inaccurate. Similar modern algorithms yield much better results. One such algorithm is implemented in the Octave function `ODE45`. This example shows you how to use `ODE45`.

- Go to our blackboard page, and download the script `ODE45_Example.m`. Save the script on your computer desktop.
- Read the comments in the file `ODE45_Examples.m`. It will use a fancy numerical technique to approximate a solution to the IVP
$$\frac{dy}{dt} = -2ty^2, \qquad y(0) = 1 \tag{1}$$
which is the same one you computed the slope field for in the first section.
- Execute the script. Compare the resulting graph (which is the approximation solution to equation (1) for $0 \le t \le 3$, to the slope field (that you saved in the screen shot).
- Use separation of variables to solve the IVP in equation (1). Then modify the script so that approximation from `ODE45` and the exact solution are plotted on the same graph. Use a solid line to plot the exact solution.
- How did `ODE45` do? Click the 'Z+' button to zoom in on any part of the graph with the magnifying tool. You might have to zoom a lot to see the difference between the two graphs.

Question 1.

(a) Create a new script and save it somewhere you can access later. Write code that uses the Octave routine `ODE45` to approximate the solution of the IVP,

$$\frac{dy}{dt} = e^{-y^2}(1-y) \qquad y(0) = 0$$

for $t = 0, 0.01, 0.02, \ldots, 2.99, 3.0$. Plot your result.

Use the file `ODE45_Examples.m` as a reference. But don't just blindly copy the whole file, look at what each part of the code does, and decide what to use (not all of it will be relevant). You might need to refer to the basic commands from last lab.

(b) Suppose $y(t)$ is the solution to the IVP considered in the previous problem. What is the approximate value of $y(3)$?

§B. **Funny stuff**

- In the command prompt, enter `eps`. What do you see?
- There are limitations to what we can compute. Type the following command `(1 + eps)/1 - 1`. What do you get? Are you surprised?
- Type the following command `(1 + eps/2)/1 - 1`. What do you get? What should have you gotten?
- What might be going on here? Type `help eps` to figure it out!