

**Math 266A Section 01 (Barsamian) MATLAB 1: Creating Graphs for Exercise 1.2#42**

In exercise 1.2#42 from Homework 1, you will investigate the Monod growth function

$$r(N) = \frac{aN}{k + N}, \quad N \geq 0$$

where  $a$  and  $k$  are positive constants. You will study the effect that changing  $a$  or  $k$  has on the graph of  $r$ . Exercise 1.2#42 asks you to graph three different versions of the function  $r$ , using various values of the parameters  $a$  and  $k$ . In this first MATLAB assignment, the goal is to make the graphs for that exercise. You will make four graphs rather than three, in order to see more clearly the effects of changing  $a$  or  $k$ . In making the graphs, you will acquire some important basic MATLAB skills, including:

- defining variables and functions
- graphing a function on a specified domain
- changing the line style of a graph
- graphing more than one function on the same set of axes
- adjusting the scale of the axes of a graph
- adding labels to graphs

Start the MATLAB program. You should see a mostly-empty workspace with the “>>” symbol at the left. This workspace is called the *command window*, and the “>>” symbol is called the *command prompt*. The prompt indicates that MATLAB is ready to receive input from you. You will type input after the prompt.

You will start by defining a function of one variable, and graphing it.

1. At the *command prompt*, type the word *clear* and hit . This erases any previously stored values.
2. At the *command prompt*, type *syms N* and hit . (Be sure to include the space and to capitalize the letter  $N$ .) This creates a symbolic variable called  $N$ .
3. At the *command prompt*, type *r=5\*N/(1+N)* and hit . (Be sure to include all characters shown, with correct upper & lower case and no spaces.) This creates a function  $r$  of the variable  $N$ .
4. At the *command prompt*, type *ezplot(r,0,100)* and hit . This command tells MATLAB to graph the function  $r$  on the domain  $0 \leq N \leq 100$ . The graph will pop-up in a new window entitled *Figure 100*, or something similar.

Now you will change the solid graph to a dotted graph.

5. Across the top of the graph’s window, you will see the names of various available pull-down menus: *File, Edit, View, Insert*, etc. Below this row of words, you should see a row of symbols. This row of symbols is called the *Figure Toolbar*. (If you don’t see the *Figure Toolbar*, then click on the word *View* to pull down the *View menu*, and on that menu, click on the words *Figure Toolbar*. This should put a check next to those words, causing the *Figure Toolbar* to appear.) One of the symbols on the *Figure Toolbar* is a white arrow. Click once on the white arrow. This tells MATLAB that you want to edit the plot. (Repeated clicks on this white arrow will switch you in and out of the *plot editing mode*. The MATLAB program indicates that you are in *plot editing mode* by showing a little rectangle around the white arrow on the *Figure Toolbar*.)

6. With your mouse, move the white arrow so that it touches the curve of the graph, and click on the graph. A bunch of squares or dots should appear on the graph, indicating that you are now editing the graph.
7. At the bottom of the graph window, a smaller window should appear, entitled *Property Editor – Lineseries*. Within this window, there should be a smaller window titled *line*. Clicking on the little triangle next to this window will enable you to change the line style for the graph that you are editing. Change the line style to make the graph a dotted line.
8. You are done with the graph window for now. Click somewhere in the blank space of the *command window* in order to bring that window to the front.

Now you will create three more graphs on the same set of axes.

9. First you need to tell MATLAB not to erase the graph that you just made. At the *command prompt*, type *hold on* and hit `enter`. This command tells MATLAB to not erase old graphs when a new graph is created.
10. At the *command prompt*, type  $r=5*N/(3+N)$  and hit `enter`. This creates a new version of the function  $r$ .
11. At the *command prompt*, type  $ezplot(r,0,100)$  and hit `enter`. The Figure 100 window will pop-up again, this time showing two graphs. The old graph is dotted or dashed; the new graph is solid.
12. Change the line style of the new graph to also be dotted or dashed, but using a style of dots or dashes that is different from the one you used on the first graph.
13. Return to the *command window*. You do not need to enter the *hold on* command again.
14. At the *command prompt*, type  $r=8*N/(1+N)$  and hit `enter`.
15. At the *command prompt*, type  $ezplot(r,0,100)$  and hit `enter`. The Figure 100 window will pop-up again, showing the new graph. The earlier two graphs might not be visible, depending on the scales of the axes. But they have not gone away. In a later step, you will adjust the axes and then you will see the old graphs again.
16. Change the line style of the new graph to also be dotted or dashed, but using a style of dots or dashes that is different from the ones you used on the first two graphs. (Use the method of steps 5 – 8.)
17. Return to the *command window*. You do not need to enter the *hold on* command again.
18. At the *command prompt*, type  $r=8*N/(3+N)$  and hit `enter`.
19. At the *command prompt*, type  $ezplot(r,0,100)$  and hit `enter`. The Figure 100 window will pop-up again, showing the new graph as a solid line. Leave this graph as a solid line.

Now you will adjust the axes.

20. Be sure that you are in the *plot editing mode*. (Click on the white arrow, if necessary.)
21. Click somewhere on the axes of the graph. The window below the graph should change to one entitled *Property Editor – Axes*.

22. In the window titled *Property Editor - Axes*, click on the tab called *Y axis*. This will open a smaller window. In this smaller window, there will be a small box titled *auto*. If there is a check in this box, click on the box to make the check go away. (You *do not* want the y-axis to be automatically scaled.)
23. Enter Y-limits of 0 to 9 in the boxes provided. (After you type a number in the box, you will need to either press  or click with your mouse somewhere outside the box, in order to submit the typed value.) With this change in the scale of the axes, all four graphs should now be visible.

Now you will add labels to the graph.

24. The x-axis is labeled by the MATLAB program. Your first labeling chore will be to create a label for the y-axis. You should still be looking at the window titled *Property Editor - Axes*, with the tab called *Y axis* selected. To create a label for the y-axis, type the symbols  $r(N)$  into the empty box called *Y-label*.
25. In the Figure 100 window, above the graph, you should see the title  $8N/(3+N)$ . The MATLAB program has simply used the formula for the most recent graph as the title for the whole picture. That is not very helpful. Your next labeling chore is to make a better title. In the edit plot mode, double click on the title  $8N/(3+N)$ . The program will highlight the title by putting little black boxes around it, and the area around the formula will turn white. Erase the formula and enter the following two-line title in its place:

Four versions of the function  $r(N)=aN/(k+N)$  for exercise 1.2#42  
your name, Math 266A MATLAB 1, due Friday Jan 6, 2006

26. Your third labeling chore is to label the individual graphs. To make the labels, you need to use the *plot edit toolbar*. However, this toolbar might not be visible. To make the toolbar visible, click on the word *View* to pull down the *View menu*. On that menu, click on the words *plot edit toolbar*. The toolbar should appear.
27. On the *plot edit toolbar*, you will see a capital T. Click on this symbol. This tells the MATLAB program that you want to insert a *text box*. The cursor should change from an arrow to a cross.
28. Put the cross somewhere near the 1<sup>st</sup> graph, and click the left mouse button. At that spot on the graph, a *text box* will appear with a blinking cursor inside.
29. Type the equation  $r=5N/(1+N)$  inside the *text box*. Do not hit , because that would create a new line inside the box. Instead, when you are done typing the equation, simply click somewhere outside the box. The *text box* that you have just created can be moved around: simply click and drag it. (Can you figure out how to make the outline of the *text box* go away?)
30. In a similar way, create titles for the remaining three graphs by using *text boxes*.

Finishing up.

31. Your figure is now complete. Print it. (Click on the word *File* to pull down the *File* menu, and on that menu, click on the *Print...* symbol.)
32. Exit the MATLAB program. (Click on the word *File* to pull down the *File* menu, and at the bottom of that menu, click on *Exit Matlab*.)
33. Use the figure to illustrate your solution to exercise 1.2#42.