

MT 1800 Calculus I
Lab Worksheet 2.5 – Derivatives and Graphical Behavior of Functions

- **Purpose:** To investigate the relationship between graphs of a function and its first and second derivatives.
 - **Procedure:** This worksheet is to be completed (using *Mathematica*) by the end of this class period.
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About help in Mathematica

To find commands that you don't know in Mathematica, it is easy to use some **help** ☺.

For example, if you click on **help** in the main bar, it'll drop down a menu. **Documentation Center** will be the first option on the top.

If you go to the Documentation Center and type in "derivative of a function", a list will show up with possible headings of interest.

The first one is:

Derivative (Built-in *Mathematica* Symbol)

f' represents the derivative of a function f of one argument. `Derivative[n_1, n_2, ...][f]` is the general form, representing a function obtained from f by differentiating ...

If you click on this link it'll explain how to find the derivative of a function. You may want to use this information during this Lab.

1. Graphical Analysis of a function.

- Let $f(t) = e^{-2t^2} - t^3 - 2t^2 + 5t + 1$. Define this function in your *Mathematica* notebook.
- Plot $f(t)$ in red for t values between -5 and 5. Name your graph **fPlot**. To make the graph easily visible, increase the thickness by including the following option:

`fPlot = Plot[f[t], {t, -5, 5}, PlotStyle -> {RGBColor[1, 0, 0], Thickness[.01]}`

- Play with the command `RGBColor[1, 0, 0]` by changing the numbers in the brackets to some other values between 0 and 1. What happens?
- Find the command that will give you a derivative function. Find the derivative of the function given above.
- Plot the first derivative function, $f'(t)$, in green for t values between -5 and 5. Name your graph **fderPlot**. To make the graph easily visible, increase the thickness by including the following option:

`PlotStyle->{RGBColor[0, 1, 0], Thickness[.01]}`

- Find the second derivative of the function. Notice that to do this you have two options either find a command for a second derivative or find the derivative of the first derivative.

- g. Plot the second derivative function, $f''(t)$, in blue for t values between -5 and 5. Externally name your graph **f2derPlot**. To make the graph easily visible, increase the thickness by including the following option:

PlotStyle->{RGBColor[0,0,1],Thickness[.01]}

- h. Use the **Show** command to display the graphs of $f(t)$, $f'(t)$ and $f''(t)$ on the same axes. Remember that you gave them all different names!

2. Relationship between a function and its derivatives – Conjectures:

- a. Create a word document with the names of the people in your team.
- b. The title of the document should be:

“ Relationship between a function and its derivatives – Conjectures”

- c. Please copy and paste your last picture with all three graphs (1h) into a word document. This can be easily done by just clicking on the graph until the orange frame appears. Left click, copy and paste into word. Resize the picture to fit the document properly.
- d. Look carefully at the plot in #1.e. Based upon what you see, complete the following conjectures about graphical characteristics of the function $f(t)$:
 - If $f'(t) > 0$ for all values of t in the interval (a,b) , then the function $f(t)$ is _____ for all values of t in the interval (a,b) .
 - If $f'(t) < 0$ for all values of t in the interval (a,b) , then the function $f(t)$ is _____ for all values of t in the interval (a,b) .
 - If $f''(t) > 0$ for all values of t in the interval (a,b) , then the function $f(t)$ is _____ for all values of t in the interval (a,b) .
 - If $f''(t) < 0$ for all values of t in the interval (a,b) , then the function $f(t)$ is _____ for all values of t in the interval (a,b) .
- e. Copy this conjectures into your word document.
- f. Print the word file and turn it in ☺!