

The Graph of a Function and the Graph of its Derivative: Part 1

Michael Penna, Indiana University – Purdue University, Indianapolis

Objective

To investigate the connection between the graph of a function and the graph of its derivative.

Narrative

In this project we investigate the connection between the graph of a function f and the graph of its derivative f' . Specifically, we investigate the fact that for each x in the domain of f , $f'(x)$ is the slope of the tangent line to the graph of f at x , and that:

- f is increasing at x if and only if $f'(x) > 0$, and
- f is decreasing at x if and only if $f'(x) < 0$.

In this project we introduce the Symbolic Toolbox function `diff`: For any function f , `diff(f(x),x)` is the derivative $D_x f(x)$ of $f(x)$ with respect to x .

Task

1. Type the commands in the left-hand column below into MATLAB. The effect of each command is described in the right-hand column for your reference.

```
>> % Your name, today's date
>> % The Graph of a Function and the Graph of its Derivative: Part 1
>> clear all, close all      Clear MATLAB's workspace and close all figure windows.
>> syms x                    Let x be a symbolic variable.
>> % Task 1
>> f = inline('x^4-4*x^2')   Let  $f(x) = x^4 - 4x^2$ .
>> f1 = diff(f(x),x)        Find  $f_1 = f'(x)$ .
>> figure(1)                 Declare the figure(1) window.
>> hold on
>> ezplot(f(x), [-2.5,2.5])  Graph  $f(x)$  for  $x \in [-2.5, 2.5]$ .
>> ezplot(f1, [-2.5,2.5])    Graph  $f'(x)$  for  $x \in [-2.5, 2.5]$ .
>> hold off
```

2. Repeat Task 1 for $f(x) = x^2/(x^4 + 1)$, graphing $f(x)$ and $f'(x)$ over the interval $[-4, 4]$ in Figure 2. (You do not have to retype the 4 lines prior to the line “>> % Task 1”.)

3. Repeat Task 1 for $f(x) = x^2(x + 1)/(x^4 + 1)$, graphing $f(x)$ and $f'(x)$ over the interval $[-2, 2]$ in Figure 3. (You do not have to retype the 4 lines prior to the line “>> % Task 1”.)

At this point, make a hard-copy of MATLAB's Command Window and figure windows. Then:

3. On each of the graphics you created in this project:

- draw and label by hand the coordinate axes,
- label by hand the graphs of f and f' (label the graph of f by “ $y = f(x)$ ”, for example), and
- by hand, highlight that part of the graph of f over which f is increasing, and that part of the graph of f' over which f' is positive.

Your hard copies of MATLAB's Command Window and figure windows will be your lab report for this project. Staple these hard copies together, the Command Window on top, and then your figure windows underneath, in order.