

## Project 3.8: Differentiation

### Objective

To investigate differentiation with Maple.

### Narrative

If you have not already done so, read Section 3.8 in the text. One of the key ideas you should take away from Chapter 3 is that, as long as the limit exists, the value of

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

for any given value of  $x$  is the slope of the tangent line to the graph of  $f$  at  $x$ .

In this project we introduce the two commands:

D(f)            the derivative  $f'$  of the function  $f$  (*Note:* D(f) is a function.)  
 D(f)(x)        the expression  $f'(x)$

### Task

a) Type the command lines in the left-hand column below into Maple in the order in which they are listed.

<pre>&gt; # Your name, today's date &gt; # Project 3.8: Differentiation &gt; restart; &gt; f := x -&gt; 1/(x^2+4); &gt; (f(x+h)-f(x))/h; &gt; simplify(%); &gt; limit(%,h=0); &gt; D(f); &gt; plot({f(x),D(f)(x)},x=-4..4); &gt; f := x -&gt; x^4+3*x^2+2; &gt; f1 := D(f); &gt; f2 := D(f1); &gt; f3 := D(f2); &gt; plot({f(x),f1(x),f2(x),f3(x)},x=-2..2);</pre>	<pre>Clear Maple's memory. Let <math>f(x) = 1/(x^2 + 4)</math>. Set up the difference quotient. Simplify the difference quotient. Find the limit of the difference quotient as <math>h \rightarrow 0</math>. Compute <math>f'</math> using Maple's <math>D</math> operator. Plot the graphs of <math>f</math> and <math>f'</math>. Let <math>f(x) = x^4 + 3x^2 + 2</math>. Let f1 denote <math>f'</math>. Let f2 denote <math>f''</math>. Let f3 denote <math>f'''</math>. Plot the graphs of <math>f</math>, <math>f'</math>, <math>f''</math> and <math>f'''</math>.</pre>
--	--

At this point, make a hard-copy of your typed input and Maple's responses. Then, ...

b) on the first graphic you created in part (a), label the graphs of  $f$  and  $f'$ , and highlight that part of the graph of  $f$  over which the tangent lines (to the graph of  $f$ ) have positive slope, and that part of the graph of  $f'$  over which  $f'$  is positive.

c) on the second graphic you created in part (a), label the graphs of  $f$ ,  $f'$ ,  $f''$  and  $f'''$ .

Your lab report will be a hard copy of your typed input and Maple's responses (both text and hand-labeled graphics).

### Comments

You can also refer to D(f)(x) in Maple by `diff(f(x),x)`.