Differentiation of Transcendental Functions

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Overview

This lab uses Maple to help you practice your differentiation skills. Three different user interfaces are introduced.

- The *Derivatives* tutor takes a user-specified function, finds its derivative and plots the function and its derivative on a specified domain.
- The *Differentiation Methods* tutor shows the step-by-step application of the differentiation rules involved in finding the derivative of a user-specified function.
- The *DerivativeDrill* maplet allows the user to select types of functions and rules and then generates random problems of this type; the user has to enter the correct derivative. This maplet also provides practice entering mathematical expressions in Maple syntax.

Used properly, these are excellent tools for helping students hone their understanding of derivatives and their differentiation skills.

Maple Essentials

- The new Maple commands introduced in this lab are:

Command	Description
`exp(x)`	exponential function, e^x
`ln(x)`	(natural) logarithm function, $\ln x$
`log(x)`	(natural) logarithm function, $\ln x$
`log[10](x)`	base 10 logarithm function, $\log_{10} x$

- The *Derivatives* tutor is started from the Maple 10 user interface under the Tools menu:

  Tools → Tutors → Calculus - Single Variable → Derivatives ...

  This tutor plots a given function and its derivative. Be sure to specify a reasonable domain by entering appropriate values in the boxes labeled ***a =*** *and* ***b =****. The* ***Display*** *button displays the formula for the derivative and plots the function and derivative on the specified domain. Look at the plot to see how the derivative can be used to determine where the function is increasing and decreasing. This is a great tool to use when you need to check your answer to a problem in the text.*

- The *Differentiation Methods* tutor is started from the Maple 10 user interface under the Tools menu:

  Tools → Tutors → Calculus - Single Variable → Differentiation Methods ...

  This tutor is designed to help you practice the individual steps involved in finding the derivative of a given function. Do not be afraid to use the ***Hint*** *and* ***Apply Hint*** *— particularly when the hint suggests using the* Rewrite *rule. Also, you might find it useful to mark the* Constant, Constant Multiple, *and* Identity *rules as being understood (see the* ***Understood Rules*** *menu).*

- The *DerivativeDrill* maplet is available from the course website:

  `http://www.math.sc.edu/calclab/141L-F06/labs/` → DerivativeDrill

  This maplet generates random differentiation problems using the types of functions and differentiation rules that you select and checks if you correctly find the derivative. Start slowly and build to more complicated expressions as you gain confidence in your differentiation skills.

Preparation

Prior to the beginning of this lab, be sure you know the basic differentiation rules (including implicit differentiation).

Activities

- Here are a few extended questions to get you started.
  1. Use the *DerivativeDrill* maplet with polynomial, trigonometric, exponential, and logarithmic functions that utilize the power, product, quotient, and chain rules. Start with only one rule per problem. As you gain confidence, allow up to 2 rules in each problem.
  2. For each of the functions listed below, find the derivative and plot the function and derivative for $-5 \le x \le 5$. (Use the *Derivatives* tutor.) Examine the graphs, how can you tell which curve is the derivative and which is the original function?
     (a) $f(x) = x \cos x$
     (b) $f(x) = x^3$
     (c) $f(x) = \frac{1}{3}x^3 - x^2 - 3x + 4$
     (d) $f(x) = x^2 + 4x - 6$
     (e) $f(x) = e^{x/2}$
  3. For each of the functions listed below, find the derivative and plot the function and derivative for $0 < x \le 10$. Again, notice the differences between the original graph and the derivative.
     (a) $y = \ln(\frac{1}{x})$
     (b) $y = \ln(x^2)$
     (c) $y = (\ln x)^2$
     (d) $x \ln x$
  4. List the rules involved in finding the derivatives of each of the following. (Use the *Differentiation Methods* tutor.)
     (a) $y = x \sin x$
     (b) $y = x^3 + 3x^2 + 7$
     (c) $y = 3x^4 + x \cos x$
     (d) $y = \frac{x^2 \sin x}{\cos x}$
  5. Find the first five derivatives of $y = xe^x$. What is $\frac{d^{100}y}{dx^{100}}$?

Assignment

This week's mastery quiz has various questions about derivatives and the user interfaces you have learned to use in this lab.