

Functions and Plots

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Overview

You will likely have to deal with graphs on a daily basis in your study of Calculus and beyond. The main objective of this lab is to learn to use Maple to produce report-quality graphs of functions. This important topic was introduced briefly in the New User's Tour, but we will explore it in more detail here.

Maple Essentials

New Maple commands introduced in this lab include:

| Command | Description |
|---------------|--|
| plot | plot one or more functions on a specified window <code>plot($f(x)$, $x=a..b$);</code> plots the graph of $f(x)$ for $a < x < b$ <code>plot([$f(x)$, $g(x)$], $x=a..b$);</code> graphs two functions in a single plot *See the various plot options below. |
| factor | factors an expression <code>factor($x^2-3x-10$);</code> returns $(x+2)(x-5)$ |
| fsolve | numerically solves one or more equations for their unknowns <code>fsolve($x^2-4=0$);</code> returns the values -2.0, 2.0 *To find only real solutions in an interval, specify the interval. <code>fsolve($x^2-4=0$, $x=-3..-1$);</code> returns only -2.0 |

The options listed below may be provided to commands that create 2-D plots. While this list is not comprehensive, these options will provide a solid foundation for your exploration of Maple's 2-D plotting capabilities.

Plot Options

- **linestyle** controls the line style of curves. Choices include **solid**, **dot**, **dash**, **dotdash**.
- **color** allows the user to specify the color of the curves to be plotted. Choices include **red**, **green**, **blue**.
- **title** allows the user to give a title for the plot.
- **legend** allows the user to provide legend entries for a plot.

Note: *Titles and legend designations longer than one word will require quotation marks.*

Many of the **plot** options listed below can be manipulated by right-clicking over the plots and choosing from the context window. Note, however, that any changes made using right-clicking will be lost upon re-execution of the **plot** command.

Related Course Material

Section 1.4 in Stewart and Sections 1.4, 2.2, and 2.3 in *CalcLabs with Maple*

Choosing an Appropriate Viewing Window

The first step in graphing an equation is to determine which rectangular portion of the xy -plane you want to display (the viewing window). In deciding this, you should use your knowledge of algebra and consider the following:

- What are the domain and range of the given function? Knowledge of the domain and range of a function is often enough to determine a good viewing window.
- What is the general shape you expect to see? When graphing polynomials, for example, it can help to already have an idea of what basic polynomial shapes look like.
- When you have chosen a good viewing window you should be able to see all the main features of the graph. For example, can you see the intercepts, maxima, minima?

Example: Determine appropriate viewing windows for each of the following functions.

a. $f(x) = \sqrt{8 - 2x^2}$ (Page 47, Example 2) b. $g(x) = 750x - 110x^2 + 4x^3$

Creating a Report-Quality Graph

A report-quality graph should be accurate and visually appealing. If more than one function is graphed, the curves should be distinguished from one another and properly referenced in the legend.

Example: Create one plot that displays the graph of both $f(x) = \sqrt{x}$ and $g(x) = |x|/2$.

Finding Zeros and Points of Intersection

It is often very useful to determine the zeros of a particular graph or determine the point of intersection when two functions are graphed together. The `fsolve` command is very useful in these situations. Remember, however, to consider the graph – you may need to specify intervals to determine all the values.

Examples:

1. Find all solutions of the equation $5 + 20x - x^2 = 0$.
2. Graph $f(x)$ and $g(x)$ together and determine all points of intersection.
 $f(x) = 2x^3 - 5x^2 + x + 2$ $g(x) = 10\sin(x)$

Additional Practice

1. Determine appropriate viewing windows for each of the following functions. (Page 51)
 - a. $f(x) = \sqrt[4]{81 - x^4}$
 - b. $f(x) = x^3 - 225x$
 - c. $f(x) = 12\sin(\frac{1}{80}x)$
2. Create one plot that displays the graph of $f(x) = 2\sin(4x)$, $g(x) = 2 + \cos(\frac{x}{2})$, and $h(x) = \sin(x)$ on the viewing window $[-\pi, \pi] \times [-4, 4]$.
3. Find all solutions of the given equations.
 - a. $x^2 = \sin(x)$ (Ex. 21, Page 51)
 - b. $2x^3 + 11x^2 - 7x - 6 = 0$
4. Graph $f(x)$ and $g(x)$ on the same set of axes and determine all points of intersection.
 - a. $f(x) = x^4 - 3x^3 - 9x^2 + 23x + 8$
 - $g(x) = x^3 - x^2 - 20x$

Hint: Try window $[-10, 10] \times [-100, 100]$ to get a good graph.

Assignment

Use Maple to complete Exercises 4 and 8 on page 51 (of Stewart); Exercise 10a on page 12 (of CalcLabs with Maple); and Exercises 17 and 20 on pages 34-35 (of CalcLabs with Maple). Turn in your Maple worksheet to be graded. Attach any additional papers.

Note: $\sin^2(x) = \sin(x)^2$ in Maple.