

Introduction to Maple

Rich Wilders, David Burton, Megumi Onoda

```
> restart: with(Student[MultivariateCalculus]); with(plots):with  
(Student[Calculus1]);
```

```
[ApproximateInt, ApproximateIntTutor, CenterOfMass, ChangeOfVariables, CrossSection,  
CrossSectionTutor, DirectionalDerivative, DirectionalDerivativeTutor, FunctionAverage,  
Gradient, GradientTutor, Jacobian, LagrangeMultipliers, MultiInt, Revert,  
SecondDerivativeTest, SurfaceArea, TaylorApproximation, TaylorApproximationTutor]
```

```
[AntiderivativePlot, AntiderivativeTutor, ApproximateInt, ApproximateIntTutor, ArcLength,  
ArcLengthTutor, Asymptotes, Clear, CriticalPoints, CurveAnalysisTutor, DerivativePlot,  
DerivativeTutor, DiffTutor, ExtremePoints, FunctionAverage, FunctionAverageTutor,  
FunctionChart, FunctionPlot, GetMessage, GetNumProblems, GetProblem, Hint,  
InflectionPoints, IntTutor, Integrand, InversePlot, InverseTutor, LimitTutor,  
MeanValueTheorem, MeanValueTheoremTutor, NewtonQuotient, NewtonsMethod,  
NewtonsMethodTutor, PointInterpolation, RiemannSum, RollesTheorem, Roots, Rule, Show,  
ShowIncomplete, ShowSteps, Summand, SurfaceOfRevolution, SurfaceOfRevolutionTutor,  
Tangent, TangentSecantTutor, TangentTutor, TaylorApproximation,  
TaylorApproximationTutor, Understand, Undo, VolumeOfRevolution,  
VolumeOfRevolutionTutor, WhatProblem]
```

(1)

Basic Maple

Maple is both a word processor (like Word) and a computer algebra system (like your TI calculator) It is not as good as Word, but much better than your calculator. As such, it is a very good tool for doing and talking about mathematics. What you are reading now is what Maple calls text. If you look at the third row of command lines at the top of this Maple document you will see that the word Text is highlighted. That means that Maple is in text mode. In this mode, no mathematics is done. To do mathematics, we must enter what Maple calls a command line. To enter a command line, hold the CTRL key and hit the letter j (this will be abbreviated as ctrl j in the future). After doing so, you will see a red prompt. Maple is now ready to do math. I will use it to compute a simple math problem. I used the ^ key to create the exponent. You leave the exponent by using the right arrow key. You can specify a multiplication as I did with 56 and 234 by using the * key. Note that the two lines below are treated as a single line by Maple. Entering ctrl J generates a new "command line" which, by default is in math mode. To enter text, use ctrl J and then Insert/text.

```
> 32 + 56·234 - 111;
```

13002

(2)

Maple defaults to math mode once it is invoked. I switched back to text entry by choosing Insert/Text. Here is another command line

$$> 3 \cdot x^2 + 3x - 11$$

$$3x^2 + 3x - 11 \quad (3)$$

You can perform basic calculus on expressions like this by clicking anywhere in the blue expression and then right clicking. This activates what Maple calls "clickable Calculus". A display of basic calculus operations shows up. The next lines show the result of asking Maple to differentiate and then to integrate expression (2). Note that they are displayed in reverse order (the most recent one shows up first).

$$> \text{int}(\mathbf{(3)}, x)$$

$$x^3 + \frac{3}{2}x^2 - 11x \quad (4)$$

$$> \text{diff}(\mathbf{(3)}, x)$$

$$6x + 3 \quad (5)$$

>

Note also, that we now know the syntax to compute a derivative or integral directly. Here is an example using the syntax rather than right clicking.

$$> \text{diff}(x^2 - \sin(x), x);$$

$$2x - \cos(x) \quad (6)$$

$$> \text{int}(x^2 - \sin(x), x);$$

$$\frac{1}{3}x^3 + \cos(x) \quad (7)$$

What if we want to take multiple derivatives? Easy enough, just enter an x for each additional derivative. Later we will take derivatives with both y and x so this notation will make more sense. The calculation below computes the third derivative (3 x's!).

$$> \text{diff}(x^3 - \cos(x), x, x, x);$$

$$6 - \sin(x) \quad (8)$$

What about definite integrals? We use int and add the x limits after the function. They are entered as x=2..5, for example. Here are two examples.

$$> \text{int}(x^2, x = 2..5);$$

$$39 \quad (9)$$

This isn't very pretty. We can use the little palette of functions at the left to make it look more like real math. Click on the definite integral icon and then fill in the details to get the following:

$$> \int_2^5 x^2 dx;$$

$$39 \quad (10)$$

$$> \frac{d}{dx} \sin(x);$$

$$\cos(x) \quad (11)$$

Plots

Maple has a very good plot function which allows us to create and print graphs. As with the basic calculus functions, you can use clickable calculus to create a quick graph. If you want to specify more

of the graph's properties, you need to know the syntax for a graph.

Clickable Calculus Plots

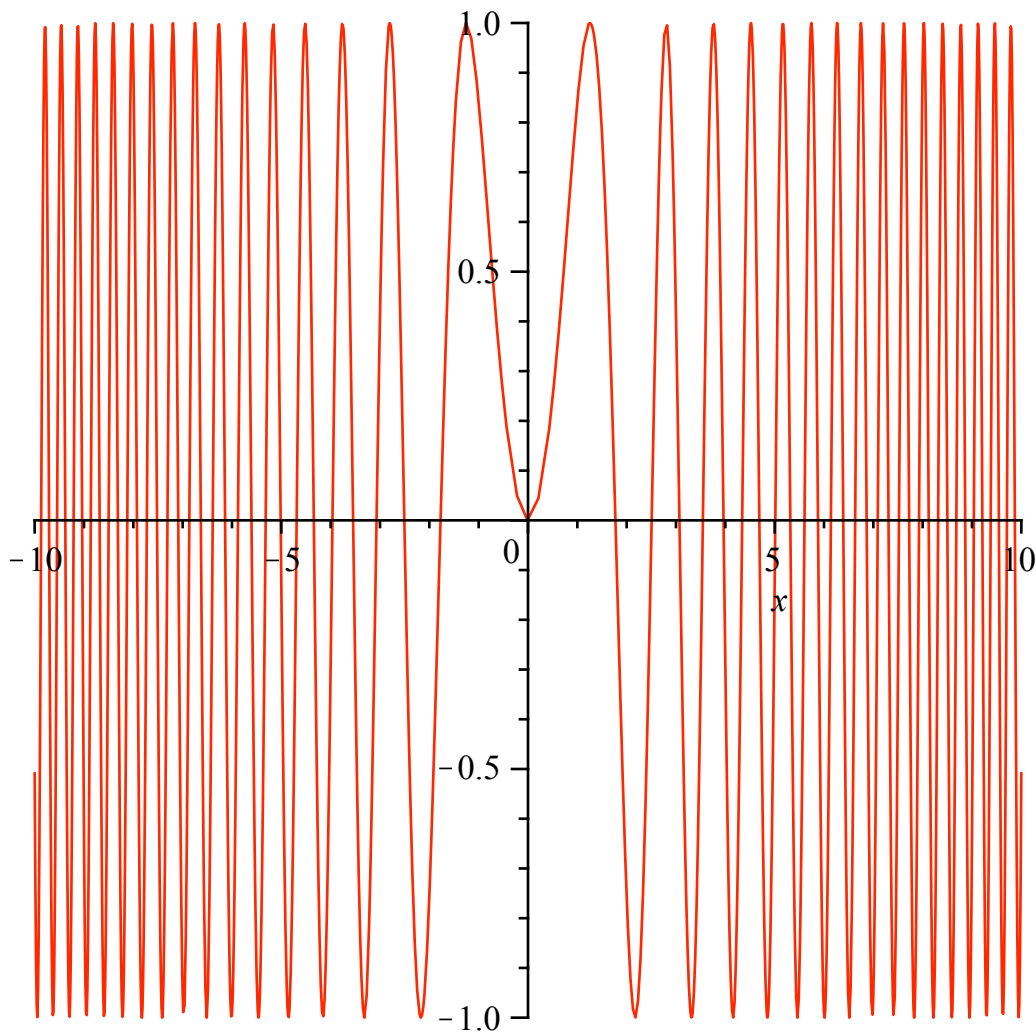
To create a quick graph just click in the blue formula you want to graph and then right click. Chose 2D plot and the graph appears!

```
> sin(x2);
```

$\sin(x^2)$

(12)

```
> smartplot( (12) )
```



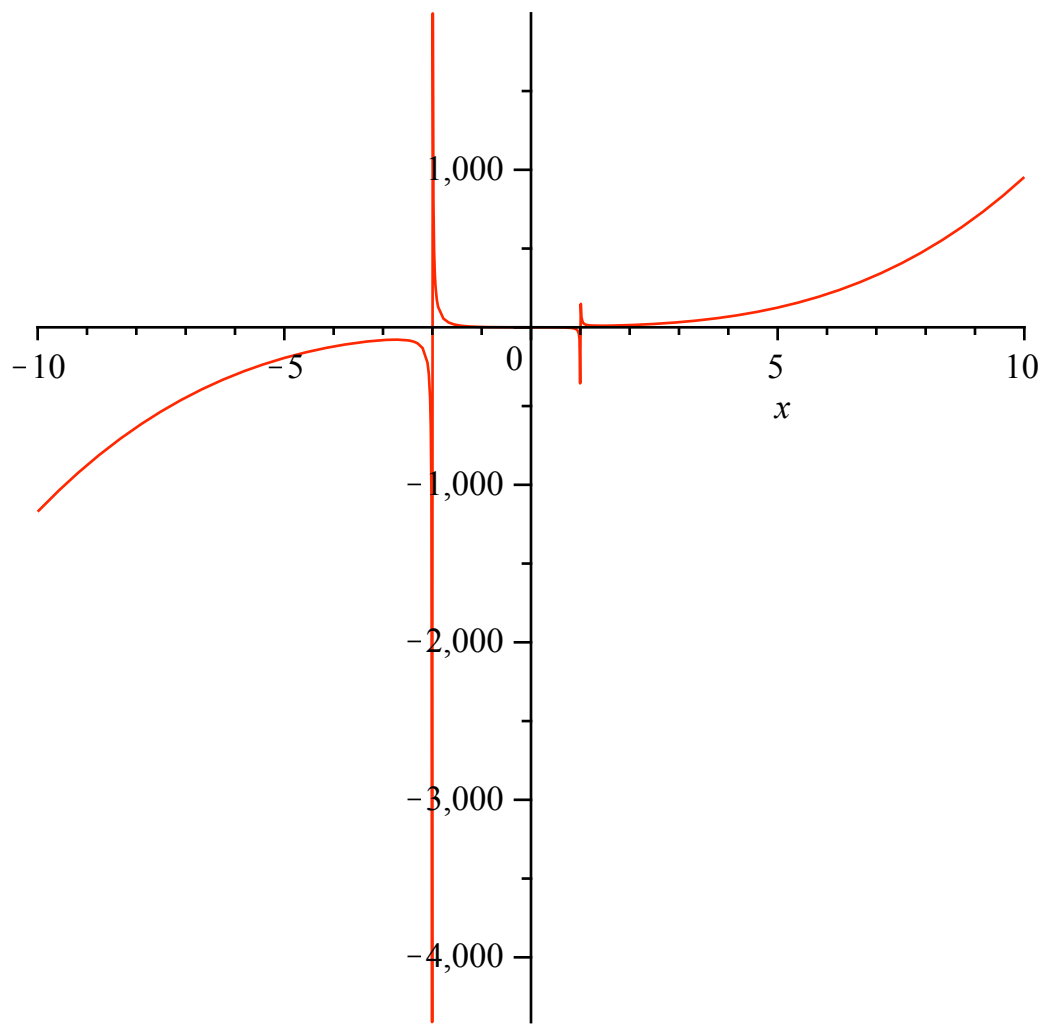
Here's an example of a rational function. This plot will require quite a bit of work to show all the features of the graph. Again, we click anywhere in the blue equation and right click. Then, choose plot, 2D.

```
>  $\frac{x^3 \cdot (x^2 + 3)}{(x - 1) \cdot (x + 2)}$ ;
```

$\frac{x^3 (x^2 + 3)}{(x - 1) (x + 2)}$

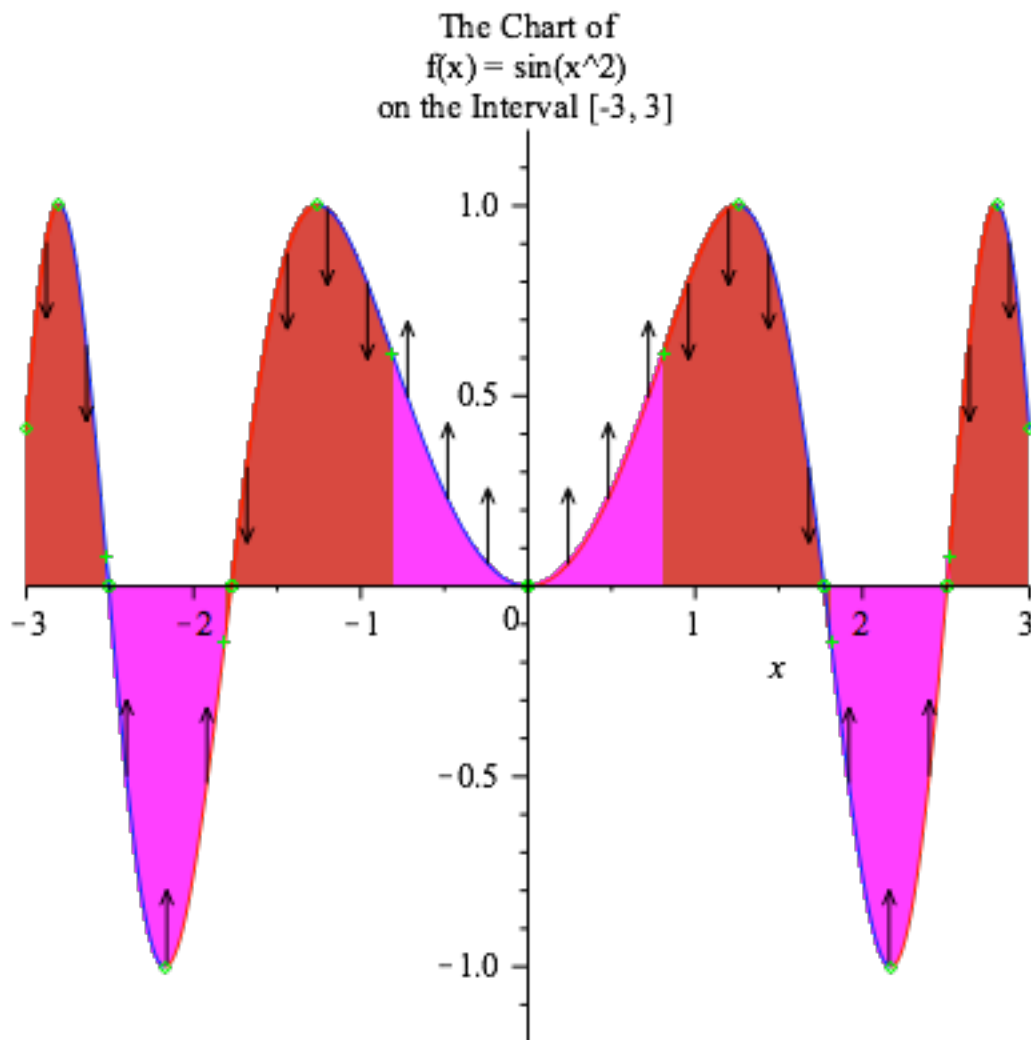
(13)

```
> smartplot( (13) )
```



Maple can do most of the work involved in creating a nice plot. We use the following command

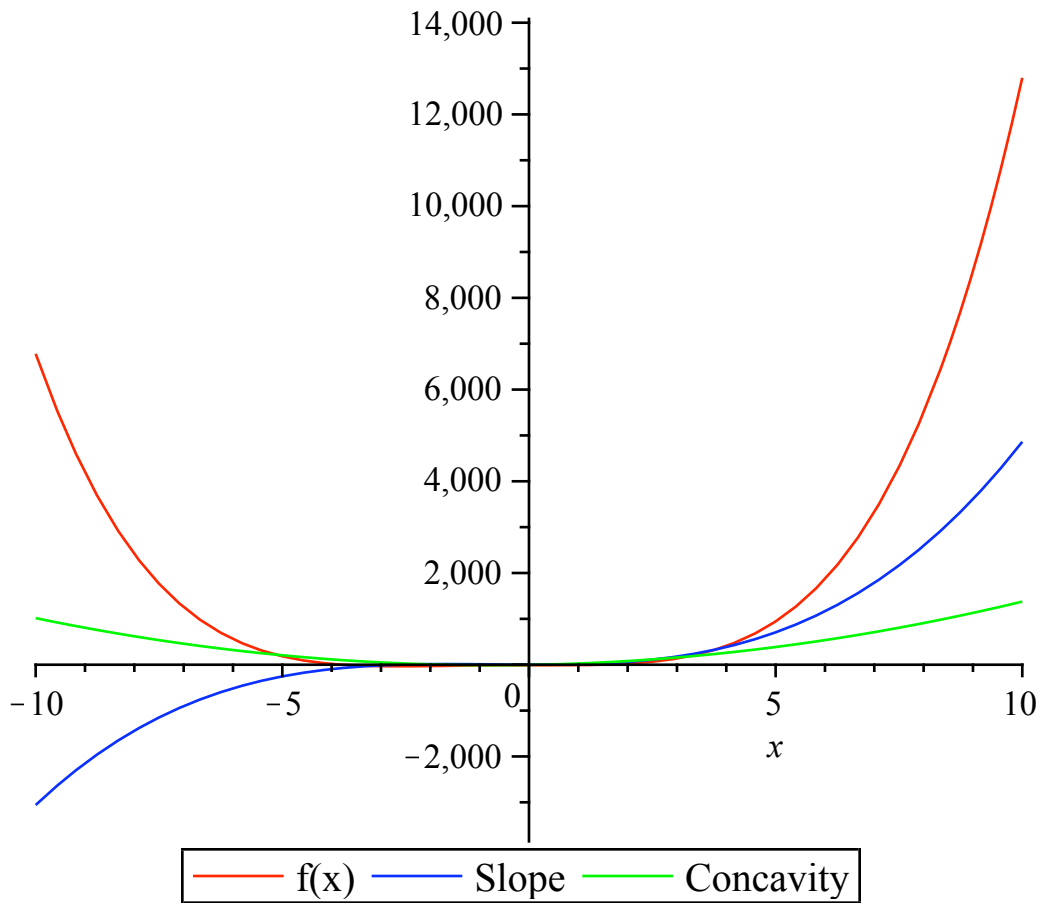
```
> FunctionChart(sin(x2), x=-3..3);
```



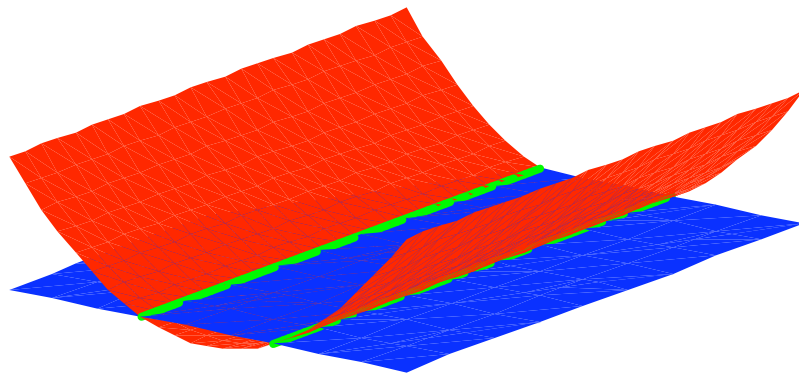
Another very nice feature is DerivativePlot. See the syntax below. It Plots the curve and its derivatives. This would enable students to construct their own FunctionChart

```
> DerivativePlot(x4 + 3 x3 - 2 x2 + x - 11, order = [1, 2], derivativeoptions[1] = [legend = "Slope"], derivativeoptions[2] = [legend = "Concavity"]);
```

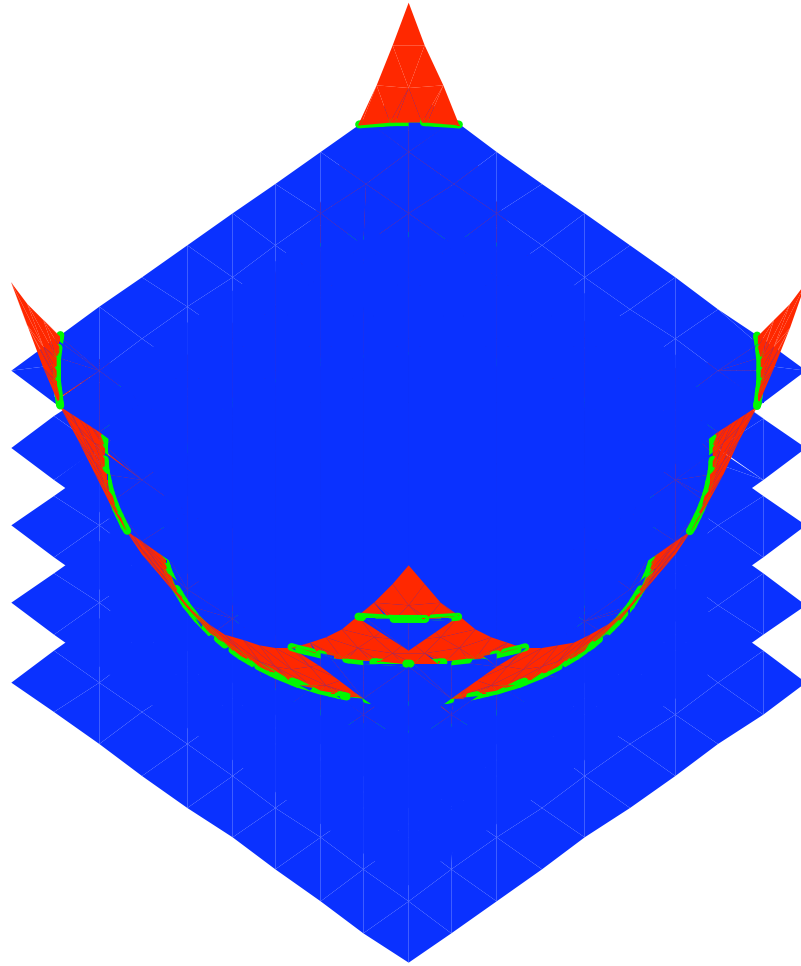
Derivatives of Various Orders of
 $f(x) = x^4 + 3x^3 - 2x^2 + x - 11$
on the Interval $[-10, 10]$



> `CrossSection(x + y^2, x + y - z = 0, x = 2 .. 4, y = -1 .. 2);`

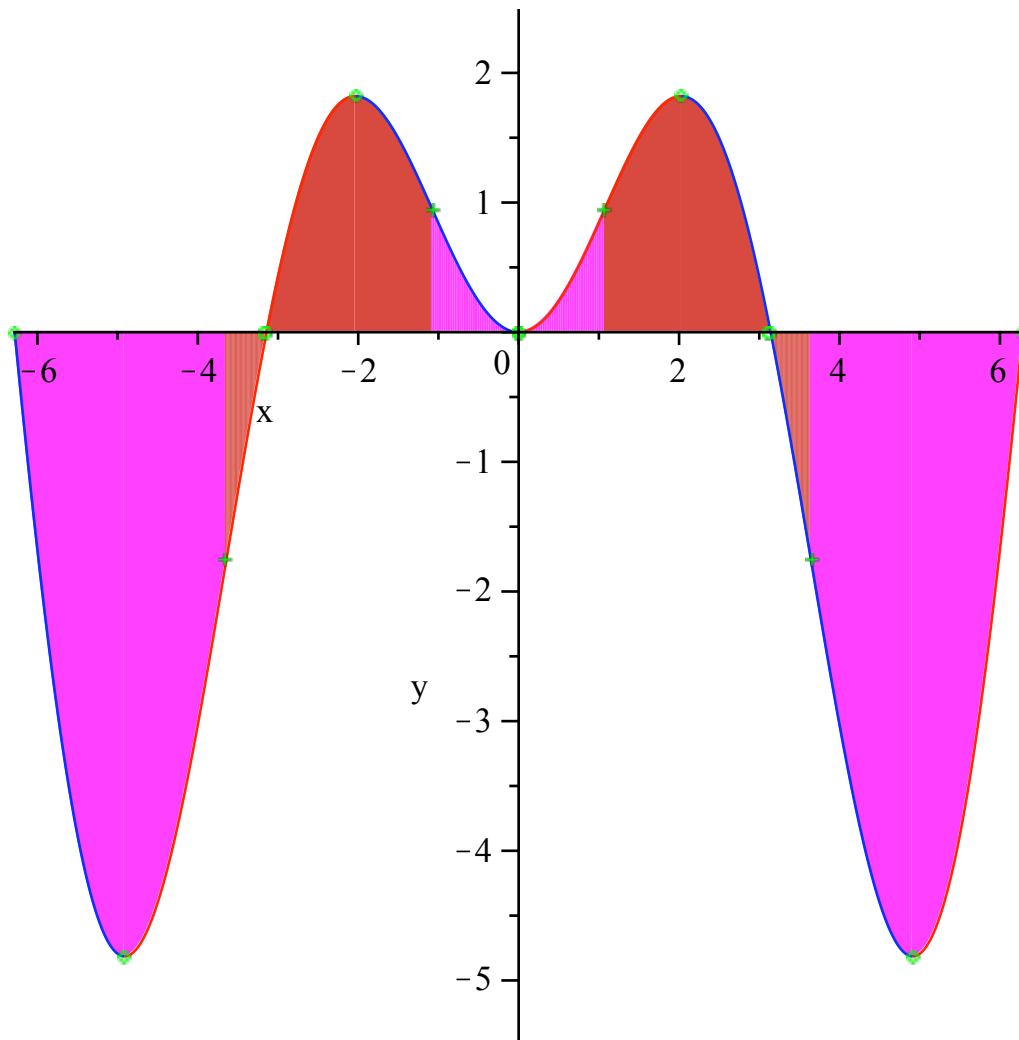


> *CrossSection*($x^2 + y^2$, $z = 0..25$, $x = -4..4$, $y = -4..4$, *planes* = 5);



Maple has several Tutors which guide you through a bit of calculus. One of these is the Curve Analysis Tutor. It computes, max/mins, etc.

```
> CurveAnalysisTutor(x * sin(x), x = -2 * Pi .. 2 * Pi);
```



>

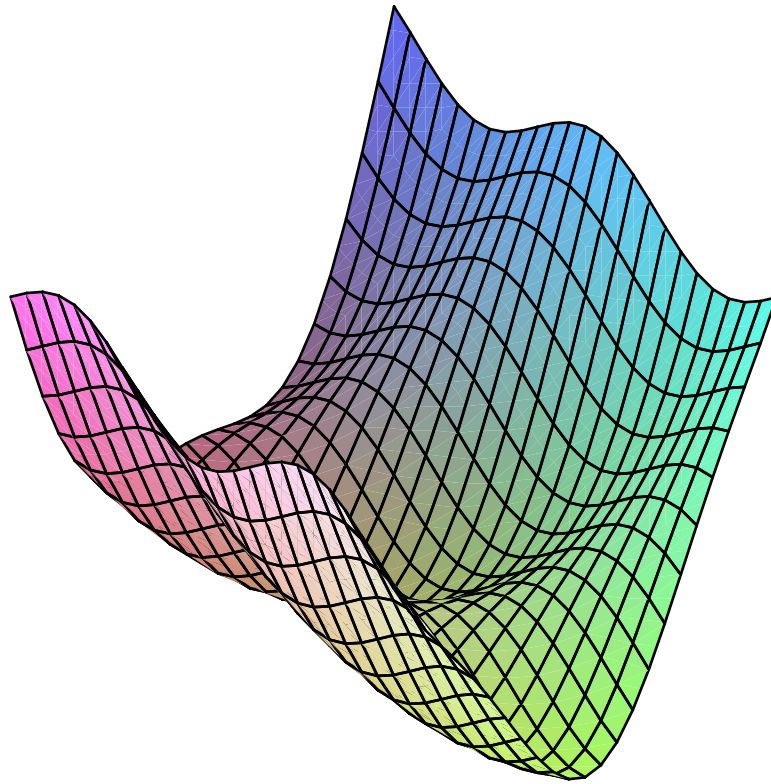
Clickable Calculus will also generate 3D graphs with just a right click. Enter the function, right click, choose plots, and then choose the type of plot you want. Clicking in the plot opens up all the plot formatting options in the third row of task bars. Notice that you can refer to an equation by its number!

> $x^2 + 3 \cdot \sin(x + y);$

$$x^2 + 3 \sin(x + y)$$

(14)

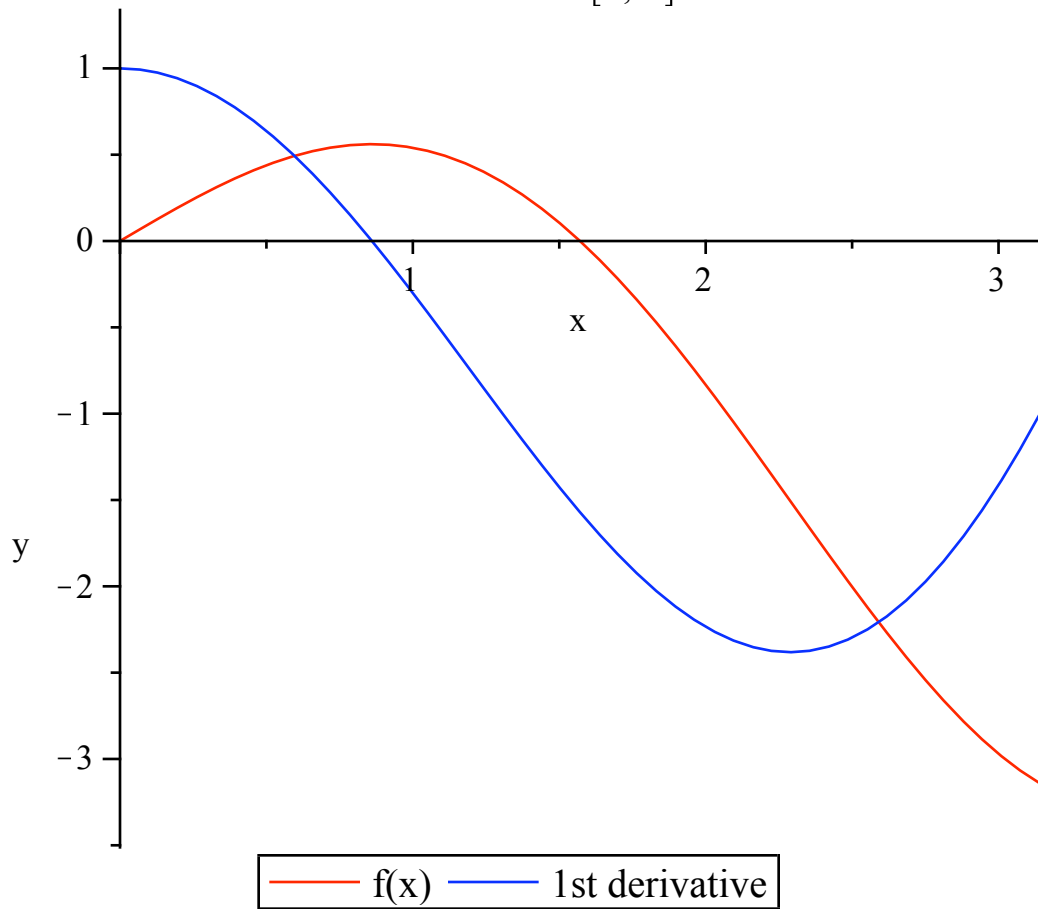
> *smartplot3d*[x, y]((14))



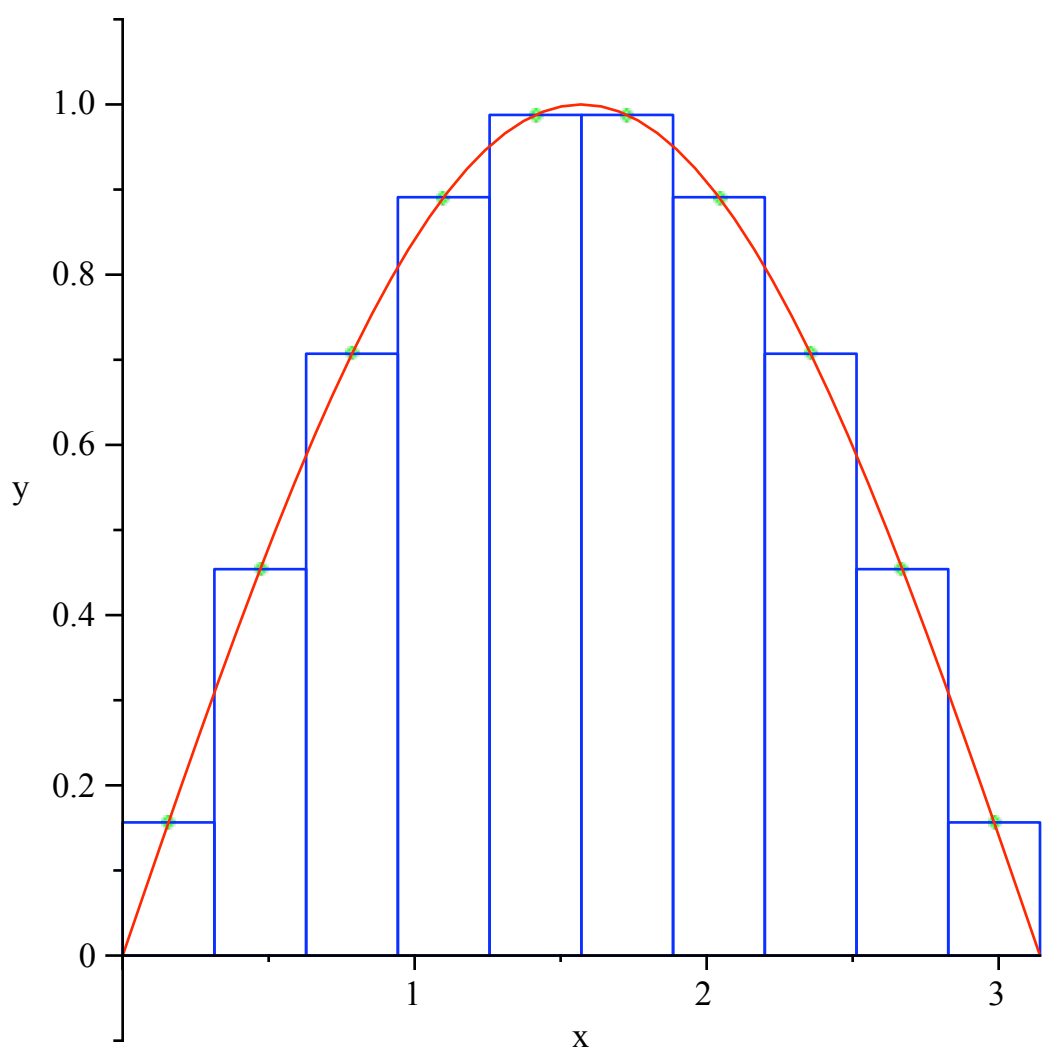
Finally, for a great list of worksheets created by the Maple folk execute the command below.

- > *?examples/index;*
- > *DerivativeTutor();*

The Derivative of
 $f(x) = x \cos(x)$
on the Interval $[0, \pi]$



```
> ApproximateIntTutor( );
```



>