Using Symbolic Mathematical Software

In the modern world, to become a successful user of Mathematics requires a person to understand and effectively apply a relatively large body of mathematical ideas starting with basic numerical and algebraic tools. Students in calculus accumulate a significant arsenal of formulas, including derivatives and integrals, which are often used to create even more important results. However, once a student can demonstrate a significant mastery of these tools, their application can become more or less a demonstration of fortitude rather than a demonstration of insight and a continued focus on the former (fortitude) can obstruct the development of the later (insight). To assist with the mechanical application of formulas, symbolic manipulation software has been developed to aid the user's work through the vast mathematical formula minefield.

One possible choice that may be applied to this problem is Maxima. This is an open-source and free software package designed to handle tedious mathematical chores including algebra and calculus. A windows "front-end" to Maxima (known as wxMaxima) provides a graphical, menu-based interface to the program. There are many other mathematics symbolic manipulation packages available including Mathematica, Maple and Derive which are all commercial products and very expensive.

Obtaining the Software

To utilize Maxima, the user will need to browse to the download site:
http://sourceforge.net/project/showfiles.php?group_id=4933
and click on Windows version. You can also download linux rpms if appropriate.

Information on how to use Maxima can be obtained through the following:
Wikipedia: http://en.wikipedia.org/wiki/Maxima_%28software%29
Manual: http://maxima.sourceforge.net/docs/manual/en/maxima.html
10-minute tutorial: http://math-blog.com/2007/06/04/a-10-minute-tutorial-for-solving-math-problems-with-maxima/
Extended tutorial: http://www.arachnoid.com/maxima/

The student should work through the tutorials referenced above to see how basic questions can be entered in the program. Successful use of this software, like anything else in mathematics, requires practice.

Calculus IV example

For calculus IV, consider the following to compute directional derivative:

```
f(x,y) := 3*x*y – cos(x/y)
fx(x,y) := diff(f(x,y), x)
fy(x,y) := diff(f(x,y), y)
```

```
x : 2;
y : -1;
theta : %pi/3
Du(x,y,theta) = fx(x,y)*cos(theta) + fy(x,y)*sin(theta)
```

Note: 3xcos(y) may not be interpreted correctly. You will want 3*x*cos(y).

Graphing

Maxima will also graph two and three dimensional objects. Consider the following:

```
f(x,y):= sin(x^2+y^2)/(x^2+y^2);
plot3d(f(x,y), [x,-3,3], [y,-3,3], [plot_format,gnuplot]);
diff(f(x,y), x);
fx(x,y) := “drag and drop the result obtained above”
diff(f(x,y), y);
fy(x,y) := “drag again”
```

or

```
contour_plot (x^2 + y^2, [x, -4, 4], [y, -4, 4]);
contour_plot (sin(y) * cos(x)^2, [x, -4, 4], [y, -4, 4]);
F(x, y) := x^3 + y^2;
contour_plot (F, [u, -4, 4], [v, -4, 4]);
contour_plot (F, [u, -4, 4], [v, -4, 4], [gnuplot_preamble,"set size ratio -1"]);
set_plot_option ([gnuplot_preamble,"set cntrparam levels 12"]);
contour_plot (F, [u, -4, 4], [v, -4, 4]);
```