[6.51] Review of TI-89 / TI-92 Plus Calculus Tools

(This review was written by George C. Dorner, September, 2001)

This is a nice little package of programs for these two TI calculators. The package is downloadable for either calculator (which must be using the latest version of the calculator operating system, V. 2.03) from the TI online store at http://epsstore.ti.com/. Here's one of the best parts: it's free!

The package is a collection of programs which will be useful to students and teachers, mostly in calculus classes or courses where calculus is used. Once the package is loaded, the programs and functions basically become part of the calculator firmware.

Here are the programs (functions) and a comment about each:

Tangent Line and Normal Line:
These two functions compute the equations of the respective lines, given a function and a value of the independent variable. Each then displays a graph of the function and the respective line. This will be useful to teachers while teaching the derivative concept and to students to check their understanding and their homework.

Newton's Method:
For a given function and an initial guess of the independent variable, the graph of the function and successive tangent lines which estimate a zero of the function are drawn. This is nice to illustrate the Method and possibly to find a zero of a function, though there are better methods built in to the calculator. I use this to introduce Newton's Method, though.

Implicit Derivative:
This finds dy/dx given f(x,y)=0. Useful to students, but most teachers will prefer to use a method which shows the steps and concepts involved. The practical use of this function is that it will find nth derivatives implicitly, a topic which is often slighted and rarely mastered in the first course.

Curvature, Center of Curvature, and Osculating Circle:
These do the computations for any function and will be useful to teacher and student while studying these topics. The answers are given "for any x", not just for specified values of the independent variable.Thus, it is easy to explore the local behavior of a curve in 2-space and related topics of geometry such as the evolute.

The section on integration will be very useful at the outset of learning about the definite integral. It contains functions to display the graph of a chosen function on a chosen interval, together with a selected number of "approximating panels" using any of the midpoint, left-hand, right-hand, trapezoidal, or Simpson's Rule. Also, there is an option to display the Riemann sums for all methods on the same screen. Armed with the right examples, there is plenty here to clarify the teaching and understanding of the limit of such sums.

A function is included which performs the ratio test for infinite series, given a formula for the general term. Two other functions included here are not traditional calculus topics., They find the sum of either first order or second order difference equations, given the expression of the general term. In a course where discrete methods or dynamical systems are explored, these could be very useful.

Computation of four functions, the gradient, divergence, curl, and potential function, which are studied in vector calculus is included. As is the case with all the functions of this package, these may be called during the regular use of the calculator without previously entering the Calculus Tools menu. This substantially extends the usefulness of the calculator.

There are eight “Advanced” mathematical functions included. The error function, *erf()*, and the complementary error function, *erfc()*, will be useful in statistics applications, but these are also included in another free downloadable FlashWare application which duplicates the statistics functions on the TI-83. In fact, the function *TIStat.normCdf()* seems to be somewhat more accurate than *CalcTool.erf()*.

The gamma function is included here, too. Its presence may encourage exploration of this complicated topic during the second calculus course and will be an occasional aid to students in applied courses. Its accuracy seems to be good beyond 5D, plenty for beginners.

“Automatic” computation of the Fourier series of a periodic function is provided by another useful function in this utility package. It will compute a designated number of terms in the Fourier series of a function specified on a period interval. A graph of the partial sum is displayed. This will be very useful to those who wish to bring this important applied topic to a calculus course audience.

Five integral applications round out the Advanced portion. The first allows the evaluation of a two-fold iterated integral over a region which is described “curve-to-curve” and “point-to-point”, what are called Type I or Type II regions in some books. More generally, it allows the surface integral of a function over a surface given in the form z=f(x,y), weighted by a “density function”, d(x,y). The terminology and names used in these applications are not standard to most calculus books, but they will be somewhat familiar to students of physics and mechanics. More general terminology and more examples would make this more useful to students, but the function is very powerful. Another “integral of Density” for a polar region is provided by a second function here. It simply evaluates the integral of a function of r and theta over a “nice” region defined in polar coordinates.

The “Centroid of Density” function returns the coordinates of the centroid of a plane region in rectangular coordinates which is weighted with a density function depending on the two rectangular coordinate variables. And, for the same data, the “Inertia Tensor” function returns a 2X2 matrix with entries which are the moments of inertia with respect to the two axes and the (equal) products of inertia. This terminology is straight from a mechanics or physics book and doesn’t appear in most calculus books., where moments of inertia _are_ discussed. (I wonder how many calculus students will _ever_ know what an inertia tensor is?)

The last function is the curiously named “Arc Displacement” , which most calculus texts refer to as “arc length in polar coordinates.” The function name is ‘plrArcLn( ), whch seems appropriate. Again, there is a provision for including a weight function to “distribute” mass or charge or some other quantity along the curve. Thus, a problem of finding the total mass of a non-uniform wire in the shape of a known curve is facilitated.

There is a nice 40 page Acrobat manual describing the Calculus Tools package. In places it is a little too terse for my taste. The formulas which are the basis of the functions provided are not typically included, leaving open their exact interpretation. I ended up doing the examples by hand to convince myself of their meaning, but some users may be buffaloed by terminology and a paucity of examples.

My complaints are thus more about the clarity of what is available than of the execution or utility of the mathematics here. More standard terminology and a few more examples would improve this neat addition to the TI FlashWare arsenal. This will be useful on occasion to most students and users of calculus, and it could be very useful during a learning process involving any one of the techniques or topics covered. I hope we see more such packages. This one was produced by a cooperative effort of a number of the gurus of these calculators, and not by TI headquarters. Most are not mathematics teachers. I hope that this is a precursor of similar packages to come from other users incorporating material which they have found genuinely useful to themselves and not just included for commercial impact.