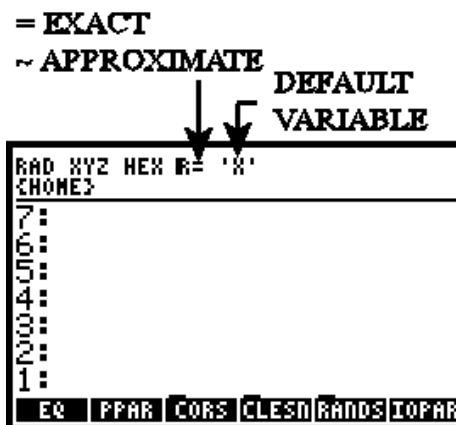


Calculator Lesson 8

Finding and Graphing Derivatives

The calculator provides three different commands for finding derivatives and they all work best if functions are set to symbolic and the arithmetic mode is set to exact (see the figure to the right). There are two ways to switch between exact and approximate modes. One is to get into the CAS MODES dialog box by pressing MODE and F3-CAS, then checking or unchecking **__Approx**. The other way is to press RS(hold) ENTER. This acts as a toggle between exact and approximate modes. To set functions to symbolic press MODE F1-FLAGS and make sure that flag 3 is not checked. Also set the **Number Format** in the CALCULATOR MODES dialog box to **FIX 3**, as we will want that later in this lesson.



The three commands that will do differentiation are

RS ∂ ,

LS CALC F1-DERIV F2-DERIV,

And

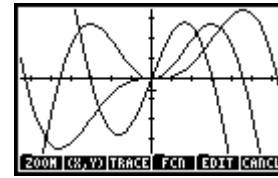
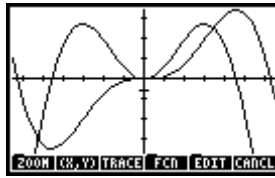
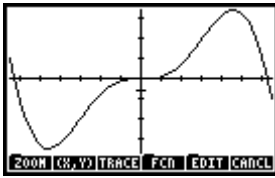
LS CALC F5-DERVX.

The first two require the expression to be differentiated to be on level 2 of the stack and the variable with respect to which you want to differentiate to be on level 1. The third command will take the derivative with respect to the default variable. The default variable can be changed in the CAS MODES dialog box by changing **Indep var**:

As an example let us find the derivative of $x^2 \sin(x)$. Put the expression on level 2 of the stack and 'X' on level 1 issue either of the first two commands given above. The result will be $2 \cdot x \cdot \sin(x) + x^2 \cdot \cos(x)$. To try the third method make sure the default variable is X and put the expression on level 1 of the stack. Issue the command and you will see $(\cos(x) \cdot x + 2 \cdot \sin(x)) \cdot x$. To get the familiar form press RS ALG F2-EXPAND. Define the function $F(x) = x^2 \sin(x)$ and differentiate 'F(X)' by the three methods and you will get exactly the same results.

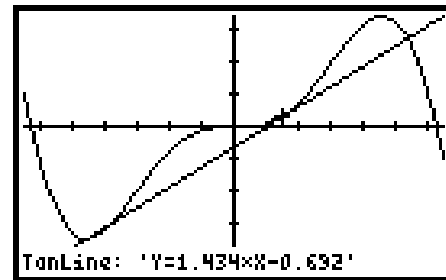
One way to graph the derivative of a function, of course, would be to simply find its derivative as shown above, then graph it. It is sometimes helpful to be able to see both the original function and the derivative on the same graph. The calculator gives us an

easy way to do that. Graph the function $F(x)$ defined above using an **H-View** of -3.25 to 3.25 and use F4-AUTO to set **V-View**. The resulting graph is shown below on the left.



Now press F4-FNC NXT F2-F', and the derivative of F will be added to the screen as seen in the center figure above. Repeat the sequence of commands and the derivative, of the derivative, that is the second derivative of F will be added to the graph as shown in the figure on the right above. This process can be repeated for as many derivatives as you wish. Now go to the PLOT SETUP dialog box (2D/3D) and notice the **EQ:** is now a list containing the original equation and all of the derivatives you added to the graph.

Set **EQ:** back to ' $F(X)$ ' and redraw the original graph. Press F3-TRACE and F2-(X, Y), then RA until the lower left corner of the screen shows .750. Now press NXT F4-FCN F3-X:OSLOPE. The bottom of the screen now shows that the slope at this point is 1.434. This value is also added to the stack. Now press NXT NXT F3-TANL and the line tangent to the curve at that point is added to the graph as shown in the figure to the right. The equation of the line shows at the bottom of the screen and is also added to the stack.



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