Programming Calculators 101

by Konstantin Pozin '06

So you’ve filled the High Score lists of every game on your TI-83 Plus with your initials. You’ve even found an interesting use for the graphing tools, writing functions that make cool designs. Now what? Well, you can go back and beat all of those high scores again — or... you can explore the mysterious [PRGM] button that is to the right of the (possibly) familiar [APPS] button. That’s right, folks — we’re going to learn to program our beloved technological wonder—the graphing calculator. The language that we’re going to be using (as if we have a host of options) is TI’s version of Basic, which is extremely simple and logical, uses understandable English commands, and shares many functions with other programming languages. In fact, if you have any experience with programming, you’ll find that learning TI Basic takes no more than understanding the syntax (the way in commands are arranged and expressed). Let’s begin.

From the home screen, press [PRGM]. The EXEC menu lets you run programs currently on your calculator*, the EDIT menu lets you load existing programs for editing*, and NEW allows you to fulfill the purpose of this article — make your own new program. Using the arrow keys, choose NEW and press [ENTER]. Enter a name for your program, 1-8 characters in length, with a letter for the first character. Our first example will be the quadratic formula, so you can name the program QUADFORM. Press [ENTER]. You’re now about to edit the blank program. On the first line of the program, let’s give the user (likely yourself) a reference as to what the program will be asking. Press [PRGM] again and you’ll see a list of commands that you can insert (you’ll only see these lists while you’re editing a program). Select I/O (that’s short for “Input/Output”) and choose 3:Disp. This will insert the Disp command, which causes the program to show the numbers, variables, or strings of text that follow it. Type in the generic equation in quotes: “AX^2+BX+C=0” (you can find “=” by pressing [2nd][MATH][1]). Now press [ENTER] to go to a new line. From the [PRGM] CTL (control) menu, choose 2: PROMPT, and then type in A,B,C. This will cause the calculator to prompt the user for the values of the variables A, B, and C.

Press [ENTER] again. Now type in (-B+√(B^2-4AC))/(2A) [STO→]D. This will store the first root of the equation to the variable “D”. On a new line, enter (-B-√(B^2-4AC))/(2A) [STO→] E, thus storing the second root to E. Now, on a new line, tell the calculator to display the two roots:

Disp “ROOT 1=”,D, “ROOT 2=”,E. Congratulations! You’ve just completed your first program.

Now, press [2nd][MODE] to return to the home screen, and to see your creation in action, select its given name from the [PRGM]→EXEC menu. The entire program listing and a sample output are shown in Figure 1.

![Figure 1](image-url)
Now let's try something a little more complicated. We'll write a program that will do the sum of a function over X between two values (if you don't yet know what this means, don't worry — you'll learn it in M$5). Create a new program and call it something along the lines of FCNSUM. We'll label the first line of the program so that we can return to it later (you'll see why). Choose 9:Lbl from the [PRGM]→CTL menu and type in 0 (zero). Now our program has a label called Lbl 0. On a new line, we'll use the Input function to ask the user a “question.” Use [PRGM]→I/O→1:Input to insert the input function, and continue the line with “START I=?”, I (the part before the comma is the “question,” and the part after the comma is the variable to which the answer will be stored.) On a new line, enter Input “END N=?”, N.

We should make sure that N is greater than or equal to I. Insert the next 5 lines as follows: If N<I: Then: Disp “N<I”: Goto 0: End: (If is found at [PRGM]→CTL→1:If; “<” is found at [2nd][MATH]→5:<; Then is found at [PRGM]→CTL→2:Then; Goto is found at [PRGM]→CTL→10:Goto; and End is found at [PRGM]→CTL→7:End.) This will test whether N is less than I, and if it is, will tell the user what is wrong and send the calculator to Lbl 0 so that the user can re-enter the correct values. End closes the If/Then function. Now, we'll prompt the user for f(X) and store the function to the string variable Str1, which can be found at [VARS]→7:String→1:Str1. On a new line, enter Input “f(X)=?” , Str1. We'll use S for our sum, and since we want it to start out at zero, enter 0 [STO?] S on another line.

The next step is creating a For loop that will set X to the start value, I, and repeat the commands within the loop until X reaches the end value, N, adding 1 to X every time. On a new line, enter For(X,I,N), accessing For from [PRGM]→CTL→4:For. On the next line, enter expr(Str1)+C [STO?] C (you can find “expr(” in the function catalog at [2nd][0]). This will evaluate the expression stored in Str1 with the current value of X, and add it to our sum variable, S. On the next line, we’ll close the loop by inserting End. Now, we just have to display the result. On a new line, enter Disp “SUM=”, S, and you’re done! Quit and run your new program. The complete program listing and a sample output are shown in Figure 2.

```
PROGRAM: FCNSUM
Lbl 0
Input "START I=?", I
Input "END N=?", N
If N<I: Then
Disp "N<I"
Goto 0
Else
For(X,I,N),
Str1 :0=S
For(X,I,N),
expr(Str1)+C=S
End
Disp "SUM=", S
```

Since you’ve completed these two simple tutorials now, you can continue experimenting with the other mysterious features you noticed on the [PRGM] menu. With your newly discovered programming prowess, you can make useful programs to quickly check homework answers, instantly perform simulations and recursions that would take you a while to do manually, and even create simple games (though keep in mind that the games you probably play on your calculator now were created using entirely different programming methods that are beyond the scope of this article). The best way to learn to program is to experiment and to look at the code of others’ programs, but there are references available, including but not limited to your calculator’s user manual and websites such as ticalc.org. Enjoy!

* The programs that are marked with an asterisk on the EXEC and EDIT menus are archived, and cannot be run or edited unless you unarchive them.