A BRIEF INTRODUCTION TO TI-89 GRAPHING CALCULATORS

BY JAY SCHIFFMAN AND ABDUL HASSEN

Our intention here is to make the introduction brief. We have assumed familiarity with the calculator's keyboard. For the sake of brevity we have omitted explanations and limited examples to basic types. We have used tables to describe the sequence of keys to press for a desired operation. For example, to solve an equation we first press **F2** and then choose the option **1:solve(.** In the table we have expressed this by writing **F2 1.** As another example, **F2 4 F2 9 1** means first **F2** then **4:zeros(** then **F2** followed by **9:Trig** and lastly **1:tExpand(.** (See the last row of the table in Section 1 below.)

Note that most built-in functions can be found by pressing **CATALOG** followed by the first letter of the desired command. One can then choose the command by scrolling down, if necessary, using the down arrow.

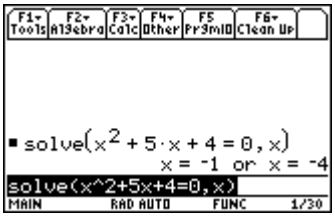
First some general commands. To clear the **HOME SCREEN** we use **F1 8.** For alphabets, first press the **ALPHA** button followed by the desired alphabet. Pressing **CLEAR** (once or twice) will delete every thing on the input line (at the bottom of the **HOME SCREEN**). To go back to the **HOME SCREEN** use either **ESC** or **QUIT**. To obtain an approximate value (in decimals) use the **GREEN DIAMOND** followed by **ENTER.** To evaluate factorials, type the number followed by **GREEN DIAMOND** followed by the **DIVISION** key.

A more detailed manual is underway. A preliminary version of the detailed manual can be obtained by contacting Professor Jay Schiffman of the Mathematics Department.

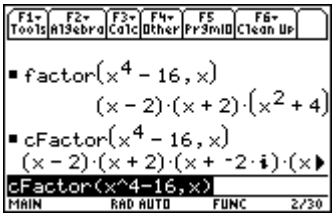
1. Algebra

All the algebraic commands are in the **F2** menu. Here is a list of some of them. The **EXAMPLE** column shows the format you should be using to enter the problem in the calculator.

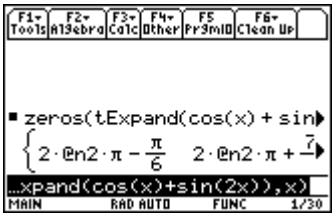
To	TI 89 MENU	EXAMPLES	TI 89 ANSWER
Solve equations	**F2 1**	solve(x^2+5x+4=0, x)	*x=-1 or x=-4*
Solve equations (with complex solutions)	**F2 A 1**	Csolve(x^4+3x^2+1=0, x)	$\frac{\sqrt{5}+1}{2}\cdot i$ or $-\frac{\sqrt{5}+1}{2}\cdot i$ or $\frac{\sqrt{5}-1}{2}\cdot i$ or $-\frac{\sqrt{5}-1}{2}\cdot i$
Solve inequalities	**F2 1**	solve(-2x+5>7,x)	$x<-1$
Solve for a variable in terms of another	**F2 1**	solve(3x+2y=6,y)	$y=\frac{-3\cdot(x-2)}{2}$
Factor expressions	**F2 2**	factor(x^3-5x^2+6x, x)	$x\cdot(x-3)\cdot(x-2)$
Factor expressions with complex factors	**F2 A 2**	cFactor(x^2+25,x)	$(x+-5\cdot i)\cdot(x+5\cdot i)$
Add fractional expressions	**F2 6**	ComDenom(1/(x+1)+2/(x+3))	$\frac{3\cdot x+5}{x^2+4\cdot x+3}$
Expand expressions	**F2 3**	Expand((x+y)^3)	$x^3+3\cdot x^2\cdot y+3\cdot x\cdot y^2+y^3$
Find the zeros of polynomials	**F2 4**	Zeros(2x^3-3x+1,x)	$\{1,\frac{\sqrt{3}-1}{2},\frac{-(\sqrt{3}+1)}{2}\}$
Find zeros of expressions involving trigs	**F2 4 F2 9 1**	Zeros(tExpand(cos(x)+sin(2x)),x)	See below
Evaluate Expressions at a point	| **(from the keyboard)**	(x^2+1)|x=2	5



To solve $x^2+5x+4=0$.



Factoring x^4-16.



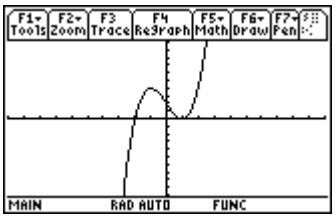
To solve $\cos x+\sin(2x)=0$.

Note that the entire input and output are not displayed for the solution of $\cos x+\sin(2x)=0$. To view the rest of the answer, use the up arrow and then the right arrow. Note also that the answer has ***2@n2*** π. This means *2n* π *where n is any integer.*

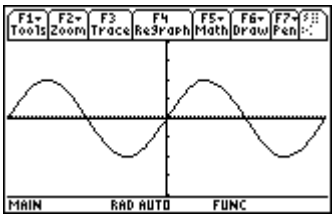
2. Graphs

To plot graphs, make sure the **MODE** is on **FUNCTIONS**(or a desired option such as **PARAMETERIC** or **POLAR** or **3D**) To plot the graph of a function, press the **GREEN DIAMOND** button followed by ***Y=(*** which is the **F1** button). Type your function and press **ENTER.** Then press **GREEN DIAMOND** button followed by **F3.** If the graph is not displayed properly, press the **GREEN DIAMOND** button followed by **F2.** Now adjust the windows as desired. Note also that you can use **ZOOM** options of the calculator by pressing **F2** immediately after you typed your function and pressed **ENTER.** If all else fails, use **F2 A(**for ZoomFit).

Once you have your graph displayed, **F5 MATH** menu has several options that allow us to analyze graphs of functions such as finding the zeros, minimum or maximum, intersection points, tangent lines, and so on. **F4** is used to select or deselect a function. Simply use the up or down arrow to highlight the function to be selected or deselected and press **F4.** We leave it to the reader to explore the other menus. Section 1.4 of the Calculus (by Stewart) textbook is the best source of examples of graphs and the importance of windows.



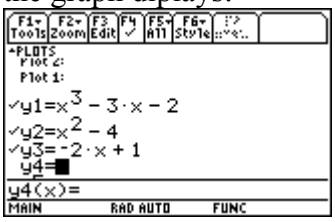
The graph of $y=x^3-3x+2$

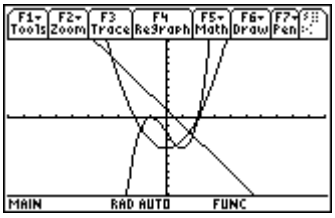


The graph of $y=\sin(x/10)$

We used $[-20\pi,20\pi]\times[-2,2]$ window

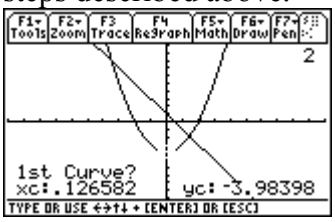
Here is a long example. (Be patient!) Let us draw the graphs of $f(x)=x^3-3x-2$, $g(x)=x^2-4$, and $h(x)=-2x+1$. We will use *y1* for *f(x), y2* for *g(x),* and *y3* for *h(x).* After typing each expression, press **ENTER.** Then press **GREEN DIAMOND** button followed by **F3** to display the graph. Here are the input and the graph diplays:



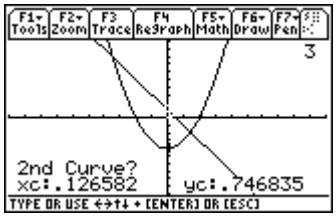


Suppose we want to find the intersection points of *g(x) and h(x).* This means we do not need *y1.* So we deselect *y1* and graph the two functions. While we are in the graph display, press **F5 5.** Notice the number 2 at the right top corner of your calculator. This refers to *y2.* You will be asked for "**1st curve?"** Press **ENTER** to select *y2* and **ENTER** again to select *y3.* Next you will be asked for a "**lower bound?"** As we can see from the graph there are two intersection points. One of the intersection points is between –4 and -3 and the other one is between 1 and 2. To find the one between –4 and –3, we can use –5 for "**lower bound?"** and thus type

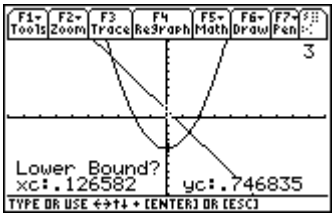
–5 and press **ENTER.** For the **"upper bound?"** press 0 and **ENTER.** The following are the results of the steps described above.



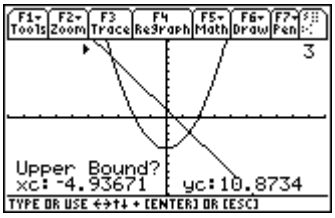
F5 5



ENTER

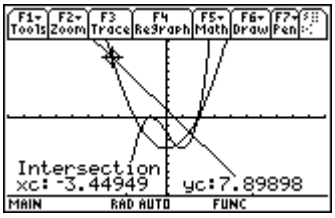


ENTER



–5 **ENTER**

0 **ENTER**



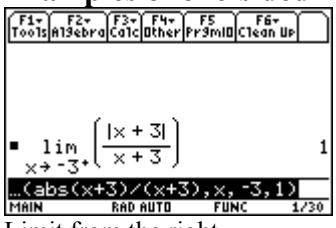
The answer is *x=-3.44949* and *y=7.89898.* We leave it to the reader to find the other intersection point and also to find the intersection points of *f(x)*and *g(x).*

3. Calculus

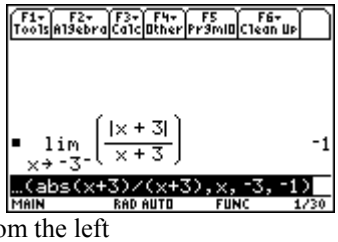
All the calculus commands (limit, derivative, integration, and so on) are in the **F3** menu. Here are some examples

To:	**TI 89 MENU**	**Example**	**ANSWER**
Find limit	**F3 3**	limit(x^3-3x-1, x, 1)	*-1*
Find right-sided limit	**F3 3**	limit(abs(*x+3)/(x+3), x,-3,1)*	*1*
Find derivative	**F3 1** or **[2nd] 8**	d(x^2, x)	*2x*
Find derivative at a point	**F3 1** or **[2nd] 8**	d(x^2,x)|x=2	*4*
Higher order derivative	**F3 1** or **[2nd] 8**	d(x^7,x,3)	$210 \cdot x^4$
Find integral	**F3 2** or **[2nd] 7**	∫(x^2, x)	$\frac{x^3}{3}$ (note the absence of +C)
Find definite integrals	**F3 2** or **[2nd] 7**	∫(x^2, x,0,1)	1/3
Sum	**F3 4**	$\sum(2k-1,k,1,10)$	100
Arc Length	**F3 8**	arcLen(x^2,x,0,5)	$\frac{\ln(\sqrt{101}+10)}{4}+\frac{5\sqrt{101}}{2}$
Taylor polynomial	**F3 9**	taylor(e^x,x,3)	$\frac{x^3}{6}+\frac{x^2}{2}+x+1$

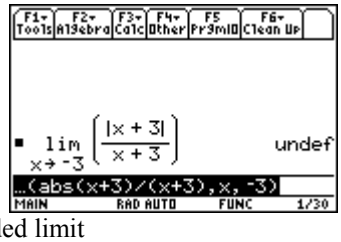
Examples of one-sided limits:



Limit from the right



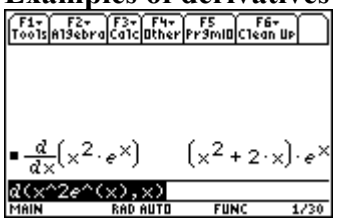
Limit from the left



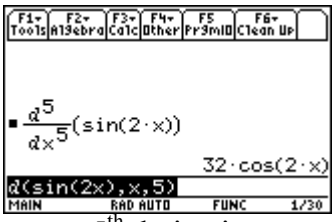
Two-sided limit

(Use **CATOLOG** key to get abs(.)

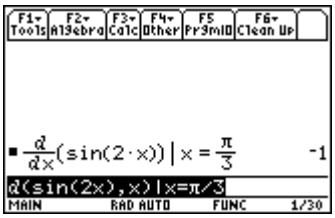
Examples of derivatives



First derivative

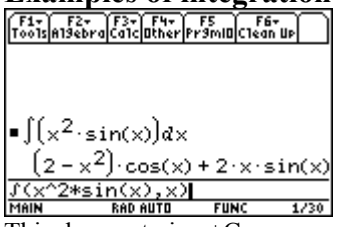


5^{th} derivative

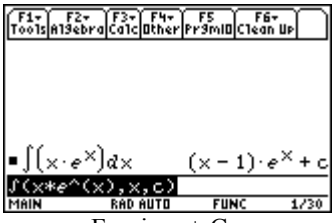


Derivative at a point.

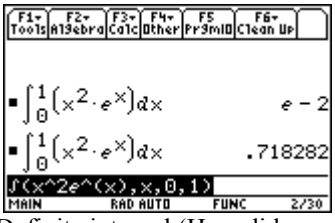
Examples of integration



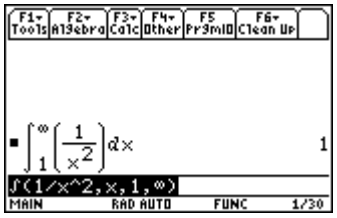
This does not give +C



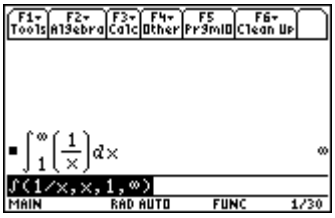
Forcing + C



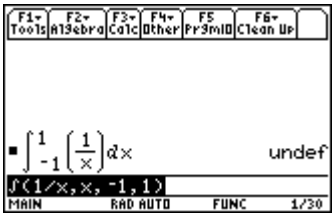
Definite integral (How did we get the second answer?)



Convergent improper integral

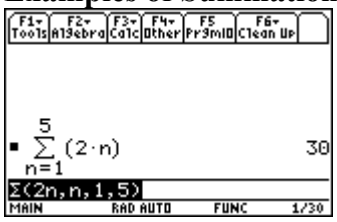


Divergent improper integral

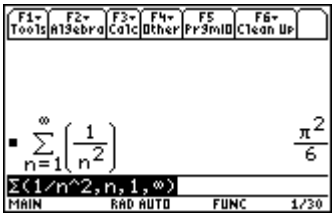


Divergent improper integral

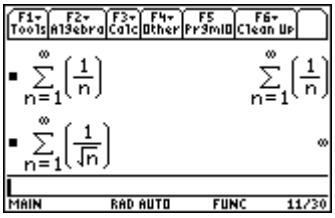
Examples of Summation:



Finite sum.



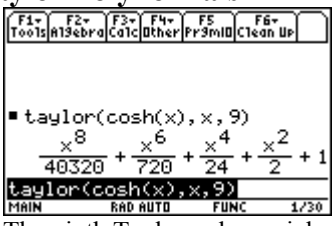
Convergent infinite series.



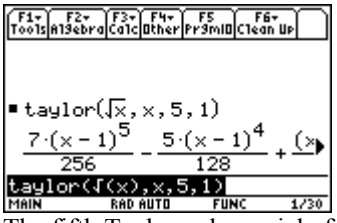
Two divergent series (Note the different forms of the Answers.)

Examples of Arc Length and Taylor Polynomials

The length of the curve $y=\sinh x$ on the interval $[0,\pi]$.



The ninth Taylor polynomial of $f(x)=\cosh x$ at $x=0$.



The fifth Taylor polynomial of $f(x)=\sqrt{x}$ at $x=1$.