

“Mastering Your Calculator” - a lecture on using the *ti 89 titanium* and the *hp 50 g* calculators
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----- FOR BOTH THE TI 89 TITANIUM AND THE HP 50 G -----

1 - Introduction - Refer to web site: <http://tbp.usu.edu>

1.1 - Find link “Engineering Tools > [Mastering your calculator](#)”

2 - Download calculator emulators

2.1 - Click on the link “[Calculators in Engineering](#)”

2.2 - Download and install the *hp 50 g* emulator:

2.2.1. Click on the link “[hp calculators editor/emulator](#)” to go to the author's web page

2.2.2. Scroll down until you find the link “[DESCARGAR](#)” below the editor's screen shot

2.2.3. Click on “[DESCARGAR](#)” (download) and save the file “HPUserEdit54.zip”

2.2.4. Return to the “[Calculators in Engineering](#)” web page and follow the instructions to install the *hp 50g* editor/emulator program.

2.3 - Download and install the *ti 89 titanium* emulator:

2.3.1. Follow the instructions in the “[Calculators in Engineering](#)” web page

NOTE: Keep both the *hp 50g* and the *ti 89 titanium* calculator emulators active to try some exercises on them

3 - Visit my “Calculators” web page:

3.1 - Go back to the “[Mastering your calculator](#)” web page

3.2 - Click the link “[My CALCULATORS web page](#)”

4 - Download hp fonts: To get *hp 50g* keystrokes in the pdf files in the CALCULATORS web site, you'll need to download and install the *hp* fonts available in the “[Download HP Fonts](#)” link.

----- FOR THE TI 89 TITANIUM ONLY -----

5 - An equation writer for the *ti 89 titanium*: The *ti 89 titanium* emulator that you downloaded will have an equation writer (eqw) already installed (the calculator does not have a factory-installed equation writer. However, one is available online for free). To check out the *eqw*, press [♦][1]. Try entering the integral:

$$\int_0^x \frac{Q}{t} dt$$

as follows:

[2nd][7] [1][+][T] [►] [T] [►] [1] [►] [X]

This result is referred to as either *textbook* style, *two-dimensional math* entry, or a WYSIWYG entry.

To evaluate this integral you can, at this point, press [ENTER], which will put the integral in the HOME screen in a *one-dimensional math* entry format, namely,

$$\int(1/t,t,1,x)$$

Press [ENTER] again to obtain the result:

$$\int_1^x \left(\frac{1}{t}\right) dt = \ln(x)$$

Translated into paper this means:

$$\int_1^x \frac{1}{t} dt = \ln(x)$$

6 - How to get the equation writer for your *ti 89 titanium* calculator (not for the emulator you have)

- 6.1 - In [My CALCULATORS web page](#), click the link “[Get an EQUATION WRITER for your TI 89 Titanium](#)”
- 6.2 - In that web site, click on the [Download](#) link to retrieve the *eqw.zip* file
- 6.3 - Create a folder called “eqw” in your disk, and extract all the files from *eqw.zip* into that disk
- 6.4 - Read the file *eqwguide.pdf* for installation and operation instructions

7 - **Linking your computer and the *ti 89 titanium*** - In order to install the equation writer in your *ti 89 titanium*, you need to get the communication software from Texas Instrument. If you have the CD that came with your calculator you will find the *TI Connect* software in the CD. If you don't have that CD, follow the link [Download HP CONNECTIVITY software](#) in [My CALCULATORS web page](#).

8 - **Installing the equation writer in your *ti 89 titanium*:** The files you need to install in your calculator are: *eqw.89z*, *eqwprgrmr.89p*, *eqwuser.89p*, and *eqwx.89z*. (The files *eqw.9xz*, *eqwprgrmr.9xp*, *eqwuser.9xp*, and *eqwx.9xz* would allow you to install the equation writer in a *ti 92 plus* calculator, which operates very similar to the *ti 89 titanium*. To find out more about the *ti 92 plus* calculator visit:

http://education.ti.com/educationportal/sites/US/productDetail/us_ti92p.html

The *ti 92 plus* has a different faceplate than the *ti 89 titanium*, but they both have very similar operating systems, however, the *ti 92 plus* has been discontinued.)

To install these files in your calculator follow one of these procedures:

- 8.1 - Copy the required files from your computer using *TI Connect*
- 8.2 - Copy the required files from another *ti 89 titanium* calculator that already has them installed

Connection cables: Both procedures require you to have the appropriate cable to connect your calculator to a computer or to other calculator. These cables should have been shipped with your calculator. Also, make sure that the required files, specifically *eqw.89z*, are located in the *Main* directory of your calculator. This directory should be available in your calculator from the factory.

8.3 - Using the VAR-LINK (VARIABLES LINK) feature in your *ti 89 titanium*:

- * To see your *MAIN* directory, use: [HOME][2nd][-] (i.e., *VAR-LINK*).
- * To open the *MAIN* directory (or any other directory) use [►] after selecting it
- * To close the *MAIN* directory (or any other directory) use [◄] after selecting it
- * To scroll up or down in your directory list use the [▲] and [▼] keys
- * To leave VAR-LINK and return to the HOME screen, press [ESC]

9 - **Creating a keyboard program to launch the equation writer:** The program, to be called *kbdprgm1* (meaning *keyboard program 1* - a program to be launched from the keyboard by pressing [♦][1]) is listed in page 11 of the document *eqwguide.pdf*. The listing of the program is the following:

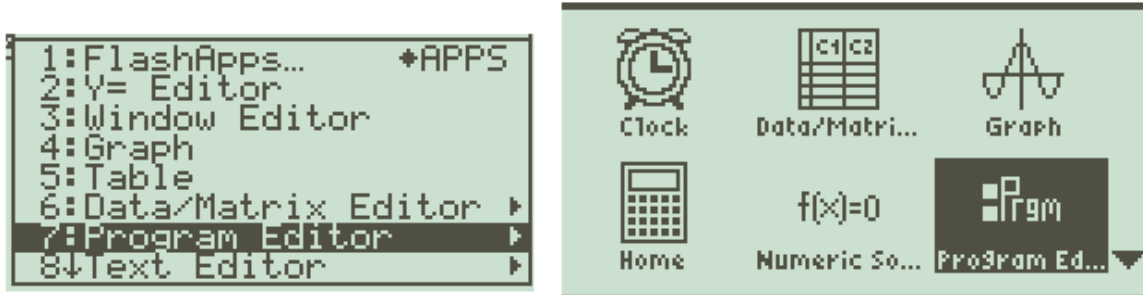
```

kbdprgm1
Prgm
main\eqw()
EndPrgm

```

To enter this program follow these instructions:

- Press the [APPS] key - your screen will produce one of the following outputs:



- The figure to the left shows a drop-down menu of all your applications (APPS). If you get this screen, scroll down to 7, or simply press [7], and then select 3: New... Press [ENTER].
- The figure to the right shows the *Apps Desktop*. If you get this screen scroll down and select the icon :Prgm Program Ed... Press [ENTER], and select 3: New... Press [ENTER] again.
- Either way you will get the following screen:



- Keep *Program* as the *Type* of program to be entered, and keep *main* as the *Folder* to use for writing your new program.
- In the *Variable* field, enter *kbdprgm1* as follows:
 - Scroll down to *Variable*
 - Press [ALPHA][ALPHA][ALPHA] (NOTE: This action locks the alphabetic keyboard. A symbol showing a white letter a surrounded by a black background shows up at the bottom of the screen.)
 - To type *kbdprgm1* find the letters associated for each key. For example, the letter K is associated with the [EE] key to the left of the [4] key, B with [()], D with [,], etc. Thus, type

[K][B][D][P][R][G][M], then, press [ALPHA][1].

NOTE: Pressing [ALPHA] when the alphabetic keyboard is locked, will unlock the keyboard.

- Press [ENTER]. The screen will show the following entries:

```

:kbdprgm1(
:Prgm
:
:EndPrgm

```

You will recognize three of the four lines in the screen as those in the program listing shown earlier. The only missing line is line number 3 (`main\eqw()`).

- To enter the missing line, first scroll down to line three in the calculator screen, then type:

[ALPHA][ALPHA]¹ [M][A][I][N] [2nd][2]² [E][Q][W] [ALPHA]³ [(] [)]

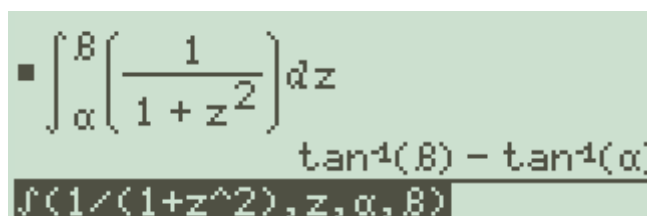
This is all you need to enter a program in the *ti 89 titanium*. The program will be saved automatically once you return to the HOME screen.

- Press [HOME] to save program and return to the HOME screen.
- To launch the equation writer use [♦][1]

Exercise: As an exercise, once you have installed the equation writer in your *ti 89 titanium* calculator, verify the following result:

$$\int_{\alpha}^{\beta} \frac{1}{1+z^2} dz = \tan^{-1}(\beta) - \tan^{-1}(\alpha) ,$$

or,



Calculator screen showing the integral equation: $\int_{\alpha}^{\beta} \frac{1}{1+z^2} dz = \tan^{-1}(\beta) - \tan^{-1}(\alpha)$. Below the equation, the function is defined as $f(1/(1+z^2), z, \alpha, \beta)$.

10 - Entering Greek letters in the *ti 89 titanium*:

- Use [2nd][+] (CHAR) to get a listing of special character collections in the calculator:



- Press the right-arrow key [▶] to list the Greek letters available in the calculator:



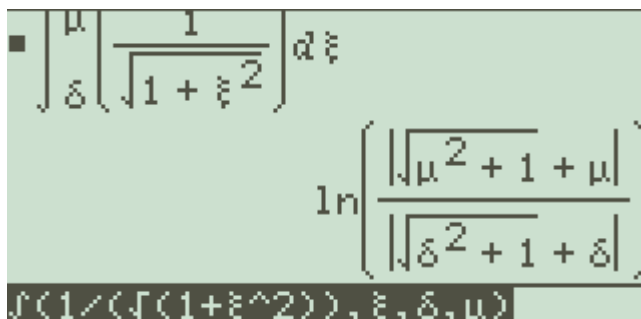
-
- 1 In this screen, you only need to enter [ALPHA] twice to lock the alphabetic keyboard.
 - 2 To enter the backslash symbol (\).
 - 3 Enter [ALPHA] here to unlock the alphabetic keyboard.

- Scroll down to see all Greek letter available, summarized in the figure below:

1: α	alpha	D: Π	PI (upper)
2: β	beta	E: π	pi (lower)
3: Γ	GAMMA (upper)	F: ρ	rho
4: γ	gamma (lower)	G: σ	sigma
5: Δ	DELTA (upper)	H: τ	tau
6: δ	delta (lower)	I: ϕ	phi
7: ϵ	epsilon	J: ψ	psi
8: ζ	zeta	K: Ω	OMEGA (upper)
9: θ	theta	L: ω	omega (lower)
A: λ	lambda		
B: μ	mu		
C: ξ	xi		

- Thus, to enter α (alpha) use: [2nd] CHAR [►][ENTER]
- To enter β (beta) use: [2nd] CHAR [►][▼][ENTER]
- To enter any other Greek letter available use: [2nd] CHAR [►], then scroll down until you find that letter, and press [ENTER]

Exercise - Verify the result:



$$\int_{\delta}^{\mu} \frac{1}{\sqrt{1+\xi^2}} d\xi$$

$$\ln \left(\frac{|\sqrt{\mu^2+1} + \mu|}{|\sqrt{\delta^2+1} + \delta|} \right)$$

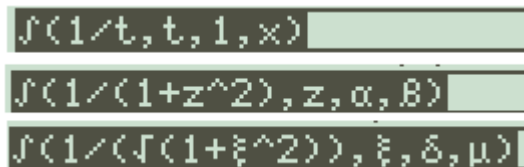
$$f(1/(\sqrt{1+\xi^2}), \xi, \delta, \mu)$$

The integral to enter is $\int_{\delta}^{\mu} \frac{1}{\sqrt{1+\xi^2}} d\xi$.

11 - One-dimensional integral entry in the *ti 89 titanium*: The examples of integrals shown above (in items 5, 9, and 10 in this document) suggest that the general form of the one-dimensional integral entry for the *ti 89 titanium* calculator is the following:

$$\int (\text{integrand}, \text{variable of integration}, \text{lower limit}, \text{upper limit})$$

Thus, if you don't want to use the equation writer you can simply enter the one-dimensional entries. For example:



$$f(1/t, t, 1, x)$$

$$f(1/(1+z^2), z, \alpha, \beta)$$

$$f(1/(\sqrt{1+\xi^2}), \xi, \delta, \mu)$$

$$\frac{d^2}{dt^2}(t^2 \cdot \sin(\omega \cdot t + \phi))$$

$$4 \cdot \omega \cdot t \cdot \cos(\omega \cdot t + \phi) + (2 - \omega^2 \cdot t^2) \cdot \sin(\omega \cdot t + \phi)$$

$$d(t^2 \cdot \sin(\omega \cdot t + \phi), t, 2)$$

NOTES:

- The one-dimensional entry format for a derivative in the *ti 89 titanium* is:

$$d(\text{expression to be derived, variable of differentiation, order of derivative})$$

- The resulting expression is too large to be shown completely in the output line in the HOME screen. To see the full result, use: [▲] and then scroll to the right or the left using [◀] and [▶]. The full result for this example is:

$$4 \cdot \omega \cdot t \cdot \cos(\omega \cdot t + \phi) + (2 - \omega^2 \cdot t^2) \cdot \sin(\omega \cdot t + \phi)$$

- To calculate a first derivative, use the delete key [←] to delete the order of the derivative, e.g.,

$$\frac{d^{\boxed{2}}}{dx^{\boxed{2}}}(\sqrt{1+x^2})$$

(a) before deleting order of derivative

Use
←
here

$$\frac{d^{\boxed{1}}}{dx^{\boxed{2}}}(\sqrt{1+x^2})$$

(b) after deleting order of derivative

16 - Summations, products, and limits: Continuing with calculus applications, we present here ways to enter summations and products using the equation writer:

- To enter a summation:
 - Launch the equation writer: [♦][1]
 - Launch the MATH menu: [2ND][5] (MATH)
 - Scroll down to *B - Calculus*: press [▼] 10 times
 - Select 4: Σ (sum): press [▶][▼][▼][▼][ENTER]

The summation symbol is ready for entry:

$$\sum_{\boxed{=}}^{\boxed{=}} \boxed{=}$$

- Enter the summand first, then press [▶] to enter the index, [▶] to enter lower limit, and [▶] to enter the upper limit.

Try this **Exercise**:

$$\sum_{k=1}^{\infty} \left(\frac{1}{k^2} \right)$$

- To enter k use [ALPHA][EE] (i.e., [ALPHA] K)
- To enter ∞ , use [\diamond][CATALOG] (i.e., [\diamond] ∞)

The result is shown below (press [ENTER][ENTER] after finishing entries in the equation writer):

The screen displays the summation $\sum_{k=1}^{\infty} \left(\frac{1}{k^2} \right)$ and the result $\frac{\pi^2}{6}$. Below the result, the one-dimensional format $\Sigma(1/k^2, k, 1, \infty)$ is shown.

NOTE: The one-dimensional format for a summation in the *ti 89 titanium* is:

$$\Sigma(\text{summand}, \text{index}, \text{lower limit}, \text{upper limit})$$

- To enter a product or a limit in the equation writer
 - Launch the equation writer: [\diamond][1]
 - Launch the MATH menu: [2ND][5] (MATH)
 - Scroll down to *B - Calculus*: press [▼] 10 times
 - Select 5: \prod (product): press [►][▼][▼][▼][▼][ENTER]
 - Or, select 3: *limit* (limit): press [►][▼][▼][ENTER]

Once you have selected one of these two operations, enter the corresponding entries, and press [ENTER][ENTER] to move the result to the HOME directory and calculate the expression. Try the following Exercises:

in eqw:		
in HOME screen:		

NOTES:

1. The one-dimensional *product* entry is: $\prod(\text{expression}, \text{index}, \text{lower limit}, \text{upper limit})$
2. The one dimensional *limit* entry is: $\text{limit}(\text{expression}, \text{variable}, \text{limit})$

Recall that the *summation*, *product*, and *limit* operations is available in the *MATH>Calculus* menu: [2ND]MATH, then scroll down as needed: [▼]

17 - Calculus (*Calc*) menu in the HOME screen - *ti 89 titanium*: the calculus operations are available in the HOME screen by pressing the [F3] key.



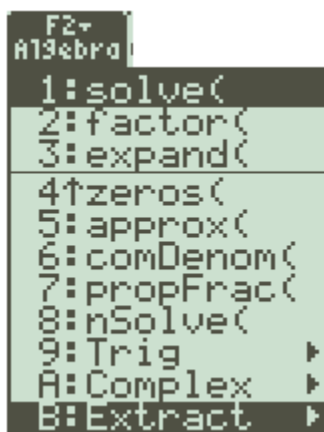
One of the functions available is the *taylor* function that produces a Taylor series expansion of an *expression*, on a *variable* (say, *x*), about $x = 0$, using all terms from order zero to a certain integer *order*. The one-dimensional format for function *taylor* in the *ti 89 titanium* is:

taylor(expression, variable, order)

Try the following **Exercises**:

$\blacksquare \text{ taylor}(\sin(x), x, 8)$ $\frac{-x^7}{5040} + \frac{x^5}{120} - \frac{x^3}{6} + x$	$\blacksquare \text{ taylor}(e^x, x, 4)$ $\frac{x^4}{24} + \frac{x^3}{6} + \frac{x^2}{2} + x + 1$
<code>taylor(sin(x),x,8)</code>	<code>taylor(e^x,x,4)</code>

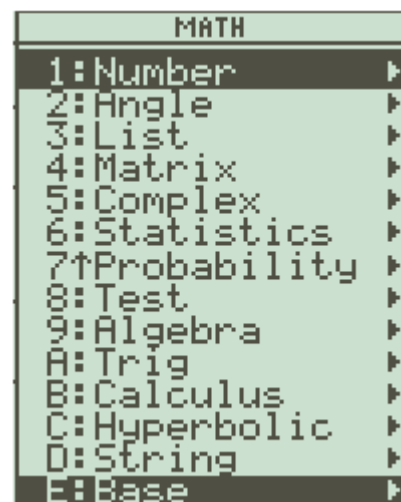
18 - Algebra (*Calc*) menu in the HOME screen - *ti 89 titanium*: For algebraic operations, the *Algebra* menu is available under the [F2] key:



Options 9: *Trig*, and A: *Complex* provide algebraic functions that apply to trigonometric expressions, and complex number expressions, respectively. The option B: *Extract* allows you to extract numerators and denominators from fractions, or left-hand and right-hand sides of equations.

19 - The **MATH** menu in the *ti 89 titanium*: Use [2ND][5] ([2ND] MATH) to launch the MATH menu, which includes the following entries:

1. Number: real number functions
2. Angle: degrees, radians, coordinate conversions
3. List: functions that apply to lists of numbers
4. Matrix: matrix, vector, linear algebra
5. Complex: complex number functions
6. Statistics: statistics of numerical samples
7. Probability: combinations, permutations, random numbers
8. Test: comparisons, logical statements
9. Algebra: algebraic operations (same as [F2])
- A. Trig: trigonometric and inverse trig functions
- B. Calculus: calculus operations (same as [F3])
- C. Hyperbolic: hyperbolic and inverse hyp functions
- D. String: operations with character strings
- E. Base: binary, hexadecimal systems, bit operations



Explore this menu on your own.

20 - **TI 89 Titanium Quick Reference guide**: In [My CALCULATORS web page](#) find the link: [TI 89 titanium Quick Reference](#) this pdf file summarizes the operation of the calculators keys.

21 - **Applications of the ti 89 titanium in Civil Engineering SURVEYING**: In [My CALCULATORS web page](#) find the link: [SURVEYING exercises with your TI 89 or TI 89 Titanium](#) - This link provides applications appropriate for surveying calculations, including:

- changing to radian and degrees modes
- calculations with degrees, minutes, seconds
- trigonometric and inverse trigonometric functions
- conversions of coordinate systems
- numerical solutions to equations
- symbolic solutions to equations
- creating directories in your calculator
- manipulating variables in your calculator
- saving equations in your calculator
- basic unit conversions

22 - **More tutorial exercises for the ti 89 titanium**: In [My CALCULATORS web page](#) find the link: [USU tutorial course on the TI 89 Titanium/TI 89](#) - Within this site click on the link: [Tutorial Exercises](#) . These tutorials cover some of the basic calculations for the *ti 89 titanium*, namely:

- Part 1 - [Quick Reference / Basic Operation](#)
- Part 2 - [Arithmetic operations and memory manipulation](#)
- Part 3 - [Operations with real numbers, units, functions](#)
- Part 4 - [Operations with complex numbers, basic programming](#)
- Part 5 - [Operations with algebraic expressions - ALGEBRA menu](#)
- Part 6 - [Solution to equations \(algebraic and numeric\)](#)
- Part 7 - [Simultaneous non-linear solutions - Use of scripts](#)
- Part 8 - [Operations with lists](#)
- Part 9 - [Operations with vectors](#)
- Part 10 - [Operations with matrices](#)

23 - The *ti 89 titanium* guidebook: In [My CALCULATORS web page](#) find the link: [TI 89 Titanium User's Guidebook](#) to download the calculator's manual. As with most calculator or computer manuals, the information provided is very limited, but it's a good reference to have handy.

24 - Statistical Applications: In [My CALCULATORS web page](#) find the link: [Calculator class notes for Probability and Statistics](#) - then follow the links for the *ti 89 titanium*.

25 - Applications of the *ti 89 titanium* in DYNAMICS (vectors, differential equations): In [My CALCULATORS web page](#) find the link: [Notes on using HP & TI calculators in DYNAMICS](#) - This link contains information on calculator applications in *Engineering Mechanics II: DYNAMICS*, including: *derivatives and integrals, indefinite integrals, velocity and accelerations in polar coordinates, symbolic and numerical solutions, vector operations, matrix operations, velocity and acceleration in rigid bodies, simultaneous non-linear equations, and ordinary differential equations*. These documents include applications for both the *ti 89 titanium* and the *hp 50g*. Particularly, review the following links: [Vector operations with calculators](#), and [Solving ordinary differential equations in calculators](#).

26 - Advanced applications for the *ti 89 titanium* - PROGRAMMING: In [My CALCULATORS web page](#) find the links: [Programming with ti 92 calculator](#) and [Advanced programming ti 92](#) . The [TI 89 Titanium User's Guidebook](#) includes a chapter on programming.

- A good reference for programming is the book: **LEARNING PROGRAMMING WITH THE TI-92⁴: STRUCTURES AND TECHNIQUES**, by Ellis, W., E. Lodi, and S. Blasberg, Texas Instruments Incorporated, 1997 - ISBN 1-886309-08-6

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-----FOR THE HP 50 G CALCULATOR -----

27 - Introducing the *hp 50 g*: [My CALCULATORS web page](#) contains two quick reference guides for the *hp 50 g*: a [Short version](#) and a [Long version](#) . The short version shows the basic operation of the calculator keys and screen icons. The long version shows the different characters available in the keyboard through the use of the [ALPHA] key, combined with the left-shift and right-shift keys.

28 - Algebraic vs. RPN modes in the *hp 50 g*: RPN (Reverse Polish Notation) was developed in the 1970s to produce efficient calculations in *hp* calculators. Algebraic mode, on the other hand, is a more natural way to perform operations in the calculator. Algebraic mode is the default mode of the *ti 89 calculator*, whereas the *hp 50g* calculator allows both Algebraic and RPN modes of operation. The following figure illustrates the blank *hp 50g* screens in both ALG and RPN mode.



ALG mode in the *hp 50g*



RPN mode in the *hp 50 g*

NOTES: (1) ALG mode uses a screen similar to the home screen in the *ti 89 titanium*, whereas, RPN mode uses a stack in which each line is numbered. (2) The screen shows 'ALG' when algebraic mode is active.

4 Applies also to the *ti 89 titanium*.

- **Changing operating mode:** The default mode for the *hp 50g* calculator is *ALG*. To change operating mode to *RPN* mode or to *ALG* mode, use: [MODE][+/-], or [MODE][CHOOS](F2) and select *RPN* or *ALG*.
- **RPN is my preferred operation mode:** RPN mode allows easier manipulation of directories (folders) and variables. *I will demonstrate the use of the hp 50g calculator in RPN mode.* NOTE: Even if the calculator is in RPN mode, algebraic calculations are possible using the equation writer ([↵][EQW]).
- See also: http://h20331.www2.hp.com/Hpsub/downloads/50gRPN_and_Algebraic_mode.pdf

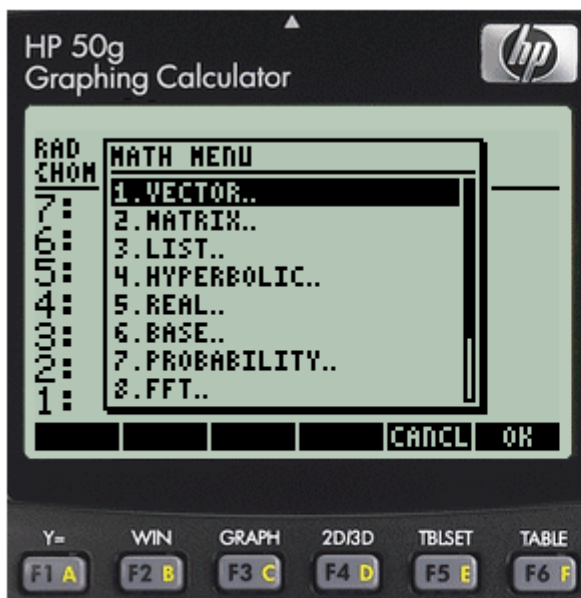
29 - **Dropdown vs. soft menu keys in the *hp 50g*:** Functions in the *hp 50g* are grouped in menus. By default, these menus are shown as **drop-down menus**, similar to those of the *ti 89 titanium*.

- To change to the option **soft-menu⁵ keys**, use: [MODE][FLAGS], and find **flag 117** by pressing [▲], seven times.
- Use the [✓CHK] key to select or de-select a flag.
 - With **flag 117** de-selected, you are in the (default) *dropdown menu* mode.
 - With **flag 117** selected, you are in the *soft menu key* mode.
- Press [OK][OK] to return to the stack.

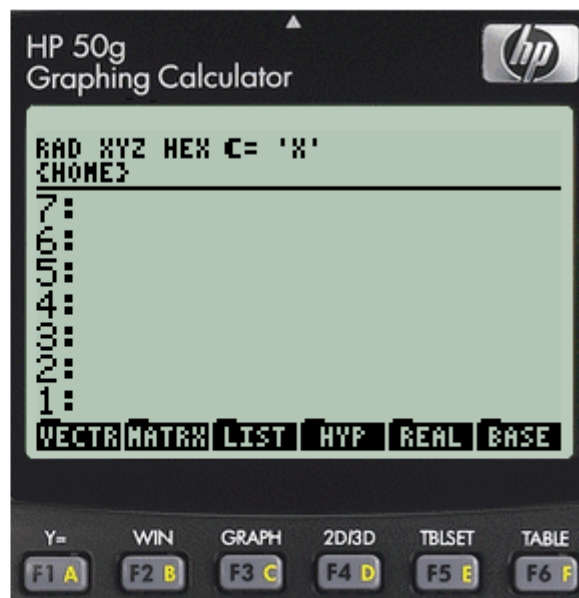
In *soft menu key* mode, the menu items are associated with the soft menu keys [F1] through [F6].

- To move forward to a new menu page use [NXT]
- To move backwards use [↵][PREV]

Try the MaTH (MTH) menu in both formats: [↵][MTH]



MTH menu in dropdown mode

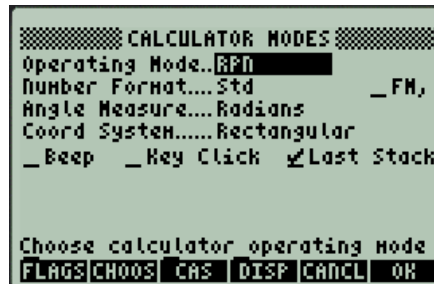


MTH menu in soft menu key mode

⁵ Soft menu keys refer to keys [F1] through [F6].

30 - Preferred settings for the *hp 50g* calculator: I prefer to use RPN operating mode, and *soft menu keys* mode. For most operations you may want to select the following settings:

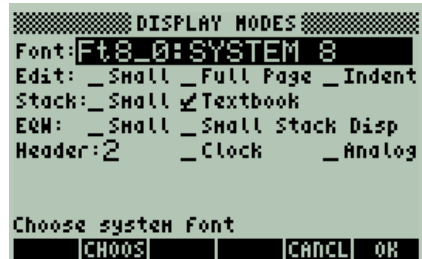
- For CALCULATOR MODES: [MODE]



- For FLAGS: [MODE][FLAGS], set flags 27, 56, 90, and 117
- For CAS (Computer Algebraic System): [MODE][CAS]⁶



- For display: [MODE][DISP]



31 - **Exact vs. Approximate modes:** *Exact* mode is the preferred mode to use in your calculator. In *Exact* mode you can calculate all kind of symbolic results. *Approx* mode will be required for some numerical calculations. However, in such cases, the calculator will ask you to change to *Approx* mode.

NOTES:

- To toggle between *Exact* and *Approx* modes press [↵](hold)[ENTER]
- Exact* mode is indicated by an equal (=) sign in the screen, while *Approx* mode is indicated by a squiggle sign (~).
- Keep your calculator in *Exact* mode as much as possible.

⁶ For algebraic calculations, the *Complex* mode will provide more general solutions (e.g., complex roots for polynomials, etc.). If you want to work in the real numbers realm, deselect the *Complex* option.

33 - **Using the equation writer (EQW):** To activate the equation writer use [↵][EQW]. Use the following symbols for calculus operations:

- Definite integral: [↵][\int]
 - Derivative: [↵][∂]
- NOTES:
- (1) Use [y^x] to enter higher-order derivatives
 - (2) The calculator uses the partial derivative symbol to indicate both ordinary and partial derivatives
- Summations: [↵][Σ]

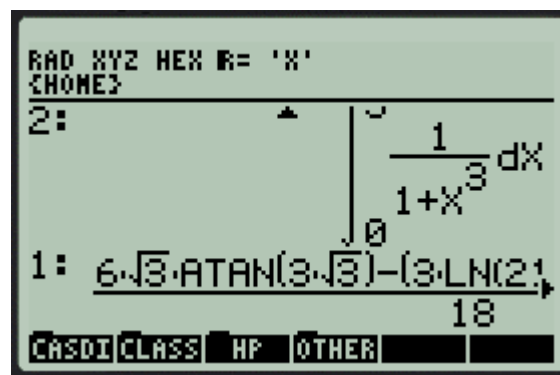
34 - **Evaluating expressions built in the EQW:** To evaluate an expression you can follow one of two procedures, after entering the expression:

1. **Move to and evaluate expression in the stack:** Press [ENTER][ENTER] (I always like to keep an extra copy of the expression), and then [EVAL]
2. **Select expression and evaluate in the EQW:** Press [▲] as many times as needed to select the entire expression in the EQW, then, press [EVAL]

Example for case 1 - evaluate in stack: This integral is built in the EQW, and then placed in the stack, with an extra copy, by pressing [ENTER][ENTER]:



Press [EVAL] to see the resulting expression:

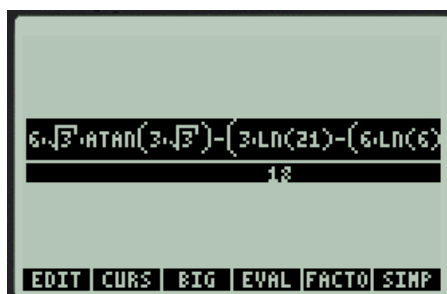


Opening an expression from the stack into the EQW: Since the calculator is in *Exact* mode (=) the result, in this case, is an algebraic expression which happens to be too long to show completely in stack level 1. To see the full expression you may want to return to the EQW by pressing [▼], i.e.,



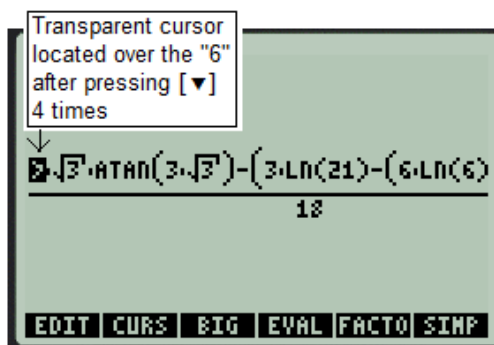
At this point you can use one of these options:

- (I) **Change to smaller font:** Press [BIG] to try to fit the expression in the EQW screen:



For this case we find that even with the small font, the expression is too large to read in the EQW screen. Try option (II).

- (II) **Navigate through the expression:** Press [▼] until the cursor turns into a transparent cursor in the leftmost term of the expression, (4 times for this example), then press [▶] (and [◀]) to move about the expression in the EQW.



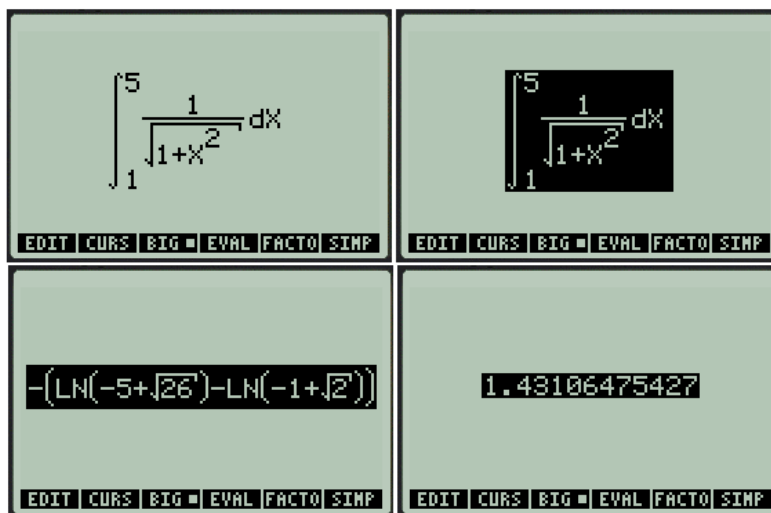
NOTE: You can press [BIG] before navigating through the expression for a larger font.

- (III) With the entire expression selected, press [→][ENTER] (i.e., →NUM, the numerical approximation). The result, after pressing [BIG], is:

1.18926325801

NOTE: The function [→][ENTER] (i.e., →NUM) can be used to find the floating-point value of any expression, whether it is in the EQW or in the stack.

Example for case 2 - evaluate in EQW: This integral is built in the EQW, then, the entire expression is selected (press [▼], six times). Press [EVAL] to evaluate integral. The result fits nicely in the EQW screen with. Finally, press [↵][ENTER] to obtain a floating-point value.



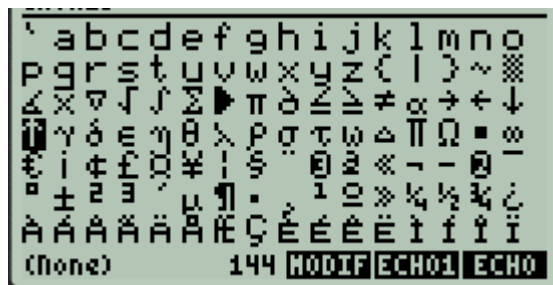
35 - Alphabetic characters in the hp 50 g: The X used in the examples of EQW expressions shown above is accessible by simply pressing the [X] key in the calculator's keyboard. To enter other alphabetic characters (i.e., letters) use the following:

- [ALPHA] + [letter]: enters the upper-case letter
- [ALPHA][↵] + [letter]: enters the lower-case letter
- [ALPHA][↵] + [letter]: enters special characters, e.g., Greek letters.

NOTE: Not all [ALPHA][↵] + [letter] combinations produce Greek letters. The Greek letters available are the following:

[ALPHA][↵][A]: α	[ALPHA][↵][E]: ε	[ALPHA][↵][S]: σ
[ALPHA][↵][B]: β	[ALPHA][↵][F]: ρ	[ALPHA][↵][T]: θ
[ALPHA][↵][C]: Δ	[ALPHA][↵][M]: μ	[ALPHA][↵][U]: τ
[ALPHA][↵][D]: δ	[ALPHA][↵][N]: λ	[ALPHA][↵][V]: ω

36 - Entering special characters: Greek letters and other characters can be entered by using [↵][CHARS]. This produces the following screen:



The cursor is shown over the ↑ character. Use the arrow keys ([▲],[▼],[▶],[◀]) to move about the collection of special characters. Once a character is selected, press [ECHO1] to copy that character to your screen.

37 - Exercises - Calculus expressions in the EQW: Try the following exercises:

$$\int_{\alpha}^{\beta} \frac{1}{1+\tau} d\tau = -(\text{LN}(|\alpha+1|) - \text{LN}(|\beta+1|))$$

$$\frac{\partial}{\partial t} \left(\frac{\partial}{\partial t} (A \cdot \text{SIN}(\omega t)) \right) = -(\omega^2 \cdot A \cdot \text{SIN}(\omega t))$$

$$\sum_{k=1}^{\infty} \frac{1}{k^3} = \frac{-\text{PSI}(1,2)}{2} = 1.20205690316$$

38 - Definite and indefinite integrals in the *hp 50g*: In [My CALCULATORS web page](#) find the link: [Notes on using HP & TI calculators in DYNAMICS](#) . Within this web site, find the link: [Definite and indefinite integrals in calculators](#) . This document will show the use of functions such as *INTVX* and *RISCH* in calculating indefinite integrals in the *hp 50g*.

NOTES:

- (1) It is not possible to use \int to calculate indefinite integrals, you need to use *INTVX* or *RISCH* for that purpose.
- (2) Function *INTVX* uses expressions in *X*, the default algebraic variable in the *hp 50g*.

39 - The **CASDIR** folder: Press [VAR] to list the variables in your calculator (If you are not in the [HOME] directory, use \leftarrow (hold) [UPDIR], then press [VAR]). One of the soft menu keys will be associated with a directory called [CASDI] (actually it's called CASDIR). Press the corresponding soft menu key to enter this directory. This directory includes a number of variables used in the calculator's algebraic system.

- Press [VX]: typically the calculator will show 'X' as the value of VX. Functions, such as *INTVX* use the value in VX as the default integrating variable.
- Press [EPS]: this is the standard tolerance value for numerical calculations (should be very small).

Press \leftarrow [UPDIR] to move back to the HOME directory.

NOTE: Try not to mess up the variables in the CASDIR directory.

34 - Surveying applications in the *hp 50g*: In [My CALCULATORS web page](#) find the link: [SURVEYING exercises with your HP 50g, HP 49g+, or HP 48gii](#) . This document reviews the calculator mode settings, and includes calculations in degrees and radians, symbolic and numerical solutions to equations, creating directories, and storing variables in directories. This document is a good point to start learning engineering applications in the calculator.

35 - Numerical solutions to equations and directory/variable manipulation: In [My CALCULATORS web page](#) find the link: [Notes on using HP & TI calculators in DYNAMICS](#) . Within this web site, find the link: [Numerical solution to equations with HP calculators](#) - Besides numerical solutions of equations, this document includes also exercises in the creation and manipulation of directories (folders), and variables, in the *hp 50g*.

36 - Additional applications in DYNAMICS (vectors, differential equations): In [My CALCULATORS web page](#) find the link: [Notes on using HP & TI calculators in DYNAMICS](#) - This link contains information on calculator

applications in *Engineering Mechanics II: DYNAMICS*, including: *derivatives and integrals, indefinite integrals, velocity and accelerations in polar coordinates, symbolic and numerical solutions, vector operations, matrix operations, velocity and acceleration in rigid bodies, simultaneous non-linear equations, and ordinary differential equations*. These documents include applications for both the *ti 89 titanium* and the *hp 50g*. Particularly, review the following links: [Vector operations with calculators](#), and [Solving ordinary differential equations in calculators](#). (This is the same as item 25 in this document).

37 - **Statistical Applications:** In [My CALCULATORS web page](#) find the link: [Calculator class notes for Probability and Statistics](#) - then follow the links for the *hp 50 g*.

38 - **hp own's tutorials for the *hp 50g*:** n [My CALCULATORS web page](#) find the link: [HP's own tutorials site](#) - This link lists a number of simple tutorials for your *hp 50 g* calculator.

39 - **The *hp 50g* User's Guide:** In [My CALCULATORS web page](#) find the link: [HP 50G/HP 49G+/HP 48Gii User's Guide by Chapters](#) - This link contains individual chapters illustrating the use of the *hp 50g* calculator. The User's Guide was written by Dr. Urroz in 2003 for the *hp 49g+* calculator. The operation of the *hp 50g* is basically the same as that of the *hp 49g+*, so this *User's Guide* applies to the *hp 50g* also.

40 - **The *hp 50g* User's Guide in Spanish:** La [Guía del Usuario](#) , is available at:
http://www.neng.usu.edu/cee/faculty/gurro/Software_Calculators/HP48_49G_Docs/HP49GPlus_UG_Spanish.pdf
 This Spanish translation of the *hp 40g+* *User's Guide* was also written by Dr. Urroz in 2003.

41 - **A more in-depth introduction to the *hp 50g* operation:** In [My CALCULATORS web page](#) find the link: [HP 50G/HP 49G+/HP 48Gii User's Guide by Chapters](#) . Within that web site, find the links to Ch.1 [Getting started](#) and Ch.2 [Introducing the calculator](#) . These chapters will give you a more in-depth introduction to the operation of the calculator.

42 - **The MTH menu:** With *flag 117* set (*soft menu keys*), use [↵][MTH] to activate the *MaTH* menu. This menu includes the following entries:

VECTR - Vector Operations	REAL - Functions for real numbers	CMPLX - Complex Numbers
MATRIX - Matrix Operations	BASE - Number base conversions	CONST - Mathematical Constants
LIST - List Operations	PROB - Probability calculations	SPECI - Special functions
HYP - Hyperbolic Functions	FFT - Fast Fourier Transform	

- See page 3-7 and on in Chapter 3 ([Simple calculations with real numbers](#)) of the [HP 50G/HP 49G+/HP 48Gii User's Guide by Chapters](#) for applications of real number functions in the MTH menu (REAL, HYP).
- See pages 4-5 and on in Chapter 4 ([Calculations with complex numbers](#)) of the [HP 50G/HP 49G+/HP 48Gii User's Guide by Chapters](#) for applications of complex number functions in the MTH menu.
- See pages 9-10 and on in Chapter 9 ([Vectors](#)) of the [HP 50G/HP 49G+/HP 48Gii User's Guide by Chapters](#) for applications of vector functions in the MTH menu.
- See Chapters [10](#) and [11](#) in the [User's Guide](#) for matrix and linear algebra applications.

43 - **Use of *SD* cards for file transfers:** In [My CALCULATORS web page](#) find the link: [HP 50G/HP 49G+/HP 48Gii User's Guide by Chapters](#) . Within that web site, find the link to Ch. 26 [Managing memory](#). Starting in page 26-6 you can find information on how to use an *SD* card to transfer files between your calculator and a computer.

44 - **Advanced applications for the *hp 50g* - PROGRAMMING 1:** In [My CALCULATORS web page](#) find the links: [Programming HP calculators using the User RPL language](#) and [Programming HP calculators in UserRPL using the PC](#) . These links provide information on programming the calculator using the *RPL* (Reverse Polish Lisp) language available in the calculator. These links make reference to Chapters 21 [Programming in User RPL language](#) and 22 [Programs for graphics manipulation](#) in the User's Guide. (see also item 53, below).

45 - **Advanced applications for the hp 50g - PROGRAMMING 2:** In [My CALCULATORS web page](#) find the link: [Programming the hp 50 g with the hpgcc C compiler](#) - This link provides a tutorial for programming your hp 50g calculator using a C compiler called hpcc. You can find hpcc at: <http://sourceforge.net/projects/hpgcc/>

46 - **hp 50g communication software:** There is a communications software for the hp 50g, which you can find in the link [Download HP CONNECTIVITY software](#) in [My CALCULATORS web page](#). However, the software is not available for Windows Vista. In such case, it's easier to transfer files back and forth between your hp 50 g and your computer by using an SD card (See item 43, above).

47 - **More tutorial exercises for the hp 50g:** In [My CALCULATORS web page](#) find the link: [USU tutorial course on the HP 50G/HP 49g+/HP 48Gii](#) - Within this site click on the link: [Download Tutorial Exercises](#) . These tutorials cover some of the basic calculations for the hp 50g, and are based on the [HP 50G/HP 49G+/HP 48Gii User's Guide](#). The tutorials available include:

- Chapter 1 - [Getting started](#)
- Chapter 2 - [Introducing the calculator](#)
- Chapter 3 - [Simple calculations with real numbers](#)
- Chapter 4 - [Calculations with complex numbers](#)
- Chapter 5 - [Algebraic and arithmetic operations](#)
- Chapter 6 - [Solution to single equations \(examples\)](#)
- Chapter 7 - [Solving multiple equations \(examples\)](#) /Using the SOLVR: see [Ch. 27](#)
- Chapter 8 - [Operations with lists](#)
- Chapter 9 - [Vectors](#)
- Chapter 10 - [Creating and manipulating matrices](#)
- Chapter 11 - [Matrix Operations and Linear Algebra](#)
- Chapter 12 - [Graphics](#)
- Chapter 13 - [Calculus Applications](#)
- Chapter 14 - [Multi-variate Calculus Applications](#)

These tutorials were prepared as a series of exercises to try in the classroom for a tutorial course I gave at USU back in the Spring Semester 2004. Thus, the documents include mostly problem statements to be solved following the techniques available in the corresponding chapters in the [User's Guide](#). Therefore, the way to go through these tutorials is to study the corresponding chapter in the [User's Guide](#), and then try the exercises in the tutorials.

48 - **Vector analysis and Differential Equations in the hp 50 g:** In [My CALCULATORS web page](#) find the link: [HP 50G/HP 49G+/HP 48Gii User's Guide by Chapters](#) . Within that web site, find the links to Chapters 15 - [Vector Analysis Applications](#), and 16 - [Differential Equations](#). These two chapters constitute two subjects of advanced mathematical applications for which the link [Download Tutorial Exercises](#) does not contain tutorial exercises. However, these [User's Guide](#) chapters contain plenty of examples to try in your own calculator.

49 - **The function catalog:** *Background:* The hp 50g is the last, and best, version of the hp 49 series calculators. It all started with the hp 49g back in 1999, followed by the hp 49g+ (and its stripped-down version, the hp 48gii). The hp 49g series, in turn, was an improvement, in terms of operating system, over the hp 48g series calculators of the 1990's. As such, the operating system in the hp 50 g is an amalgam of the old *numeric-based* operating system of the hp 48 series, and a new *Computer Algebraic System* (CAS) created for the new calculators. Thus, the collection of calculator functions available consists of those inherited from the hp 48g series, and those added in the CAS.

The catalog of functions: All the functions in the calculator can be accessed using the CATALOG: [↵][SYMB] (i.e., [↵] CAT). The functions are listed in alphabetical order. Use [ALPHA] + *LETTER*, to move the catalog pointer to the first function that starts with *letter*. For example, to find function CRDIR (Create DIrectory), type [↵] CAT, followed by [ALPHA][C]. The catalog pointer will move to function C2P, which is the first function that starts with the letter "c." Next, to find CRDIR, scroll down using [▼]. Press [CANCL].

Exercise 1 - Let's use function CRDIR to create a directory as follows:

1. Show variables and move to the HOME directory: [VAR] [←][UPDIR]
2. Type a name, say, 'TEST1', in the stack: ['][ALPHA][ALPHA][T][E][S][T] [ALPHA][1] [ENTER]
3. Next, activate the catalog and move the pointer to "c": [↩][CAT] [ALPHA][C]
4. Scroll down until the catalog pointer shows CRDIR, and press [OK]

There should be a new folder called TEST1 in your variable list (press [VAR], if needed, to check that).

Exercise 2 - Use function PGDIR (PurGe DIrectory) to delete directory TEST1, as follows:

1. Show variables, and place the name 'TEST1' in the stack: [VAR] ['][TEST1][ENTER]
2. Activate the catalog and move the pointer to "p": [↩][CAT] [ALPHA][P]
3. Scroll down until the catalog pointer shows PGDIR, and press [OK]

The folder TEST1 should have been removed from your variable list (press [VAR], if needed, to check that).

Exercise 3 - Listing catalog functions that start with an arrow: Not all functions in the catalog start with letters. Some start with Σ or with an arrow (\rightarrow). To list functions that start with an arrow use:

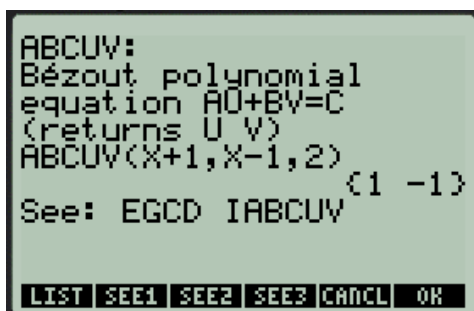
[↩][CAT] [ALPHA][↩]

This produces the listing to the left. To see functions that start with Σ , scroll the list up (see figure to the right):



50 - The *help* facility in the catalog: Functions that belong the CAS (Computer Algebraic System) of the *hp* 49g series have a *help* button associated with them in the catalog. Those functions inherited from the *hp* 48g series do not have a *help* button. Try the following exercise:

- Activate the catalog and move the pointer to "a": [↩][CAT] [ALPHA][A]
This action will move the catalog pointer to the first function that starts with an "a", namely, ABCUV. Notice that the key [F1] has a [HELP] label attached to it. Press [F1] to get the following screen:



This *help* window shows:

- (1) the function name, ABCUV
- (2) A brief explanation of the function: “Bezout polynomial equation $AU+BV=C$ (returns U V)”
- (3) An example of application, in Algebraic format: “ABCUV(X+1,x-1,2)” with its result “{1 -1}”
- (4) A list of related functions: “See: EGCD IABCUV”

The soft menu key operations available are:

- LIST Return to catalog
- SEE1, SEE2, SEE3 Open *help* screens for related functions (e.g., SEE1 for EGCD, SEE2 for IABCUV)
- CANCL, OK Cancel operation or activate function

In this example, since we are keeping the calculator in RPN mode, pressing [OK] would produce an error. Thus, press [CANCL]. (If you want to try this function type: 'X+1' [ENTER] 'X-1' [ENTER] 2 [ENTER], then find function ABCUV from the catalog, and activate it, as indicated above.

- Functions without a *help* page: enter the following keystroke sequence: [↵][CAT] [ALPHA][A][▼]



In this case the function ABS (ABSolute value) is highlighted, but no [HELP] button is available. This is so because function ABS was originally defined in the *hp 48 series* calculators, and no *help* entry is included for it in the CAS.

Thus, you can tell, by looking in the catalog, which functions belong to the original *hp 48 series* system (no [HELP] button), and which were created for the new CAS (they do have a [HELP] button).

51 - **Additional references for the hp 50g (and other hp 48, 49 series calculators):** So, where can one find information on the original *hp 48g series* functions if they're not available in the catalog *help* facility? Here's a number of references where you can find that information:

- Documentation from the *hpcalc* web site (see item 52 for more details):

See the page: <http://www.hpcalc.org/hp49/docs/misc/>. Specifically find and follow the following links, and download the appropriate documentation in those links:

1. [HP 50g Advanced User's Reference Manual Edition 2](#) - This reference manual includes a section 1 on programming, a section 2 on programming examples, and a section 3 called *Command Reference*, starting in page 3-1, which lists all the original *hp 48 g series* commands. Regrettably, this reference manual is not bookmarked, so you'll have to scroll down through the document to find information.
2. [HP 49G Pocket Guide](#) , [HP 49G Pocket Guide \(modified for duplex printing\)](#), and/or [HP 49G Pocket Guide \(on-screen reading\)](#), and [HP 49G Pocket Guide Errata](#) - These contains listing of the commands with outputs, including those in the CAS.
3. And since we are in this web page, also download the document [HP 49G vs. TI-89 Comparison](#) to see a comparison between the *hp 50g* and the *ti 89* calculator, as presented by *hp*.

52 - A depository of programs and documentation for the *hp 50g*: visit the web site <http://www.hpcalc.org> to find programs, documentation, and other interesting information about the *hp 50 g* calculator. This is one of the best related to this calculator.

53 - **Web sites tutorials and programming the *hp 50g***: Just yesterday I found the following web sites that will be very useful to learning programming with *User RPL*, and other calculator applications:

- <http://www.thiel.edu/Mathproject/CalculatorLessons/Default.htm> - Tutorials
- <http://www.thiel.edu/Mathproject/ITPHPC/Default.htm> - Introduction to Programming - find the link *Table of Contents* to get started.

----- GRAPHICS IN BOTH THE TI 89 TITANIUM AND THE HP 50 G -----

54 - **Graphic calculators and their limitations.** The *ti 89 titanium* and the *hp 50 g* are referred to as *graphic calculators*, as opposite to *scientific calculators* (the last term refers to calculators that included advanced mathematical functions useful in scientific calculations). Both have graphic capabilities that allows the user to see plots of two- and three-dimensional graphs. However, I want to give some reasons why I don't use the graphics in these calculators:

- (1) The learning curve for graphics may be steep in both calculators
- (2) The quality of the graphs is not great
- (3) Unless you use the emulator in a PC, copying graphs from a calculator's screen could be complicated
- (4) There are other options, e.g., *Matlab*, *Scilab*, *MathCAD*, *Maple*, *Maxima*, *Mathematica*, where you can produce high-quality graphs.

Nevertheless, since the calculators include graphics capabilities, we'll explore them here.

55 - **Graphs in the *ti 89 titanium***: In [My CALCULATORS web page](#) find the link: [TI 89 Titanium User's Guidebook](#) . Read and try the exercises in the chapters entitled: *Basic Function Graphing*, *Polar Graphing*, *Parametric Graphing*, *Sequence Graphing*, *3D Graphing*, *Differential Equation Graphing*, *Tables*, and *Additional Graphing Topics*.

56 - **Graphs in the *hp 50 g***: In [My CALCULATORS web page](#) find the link: [HP 50G/HP 49G+/HP 48Gii User's Guide by Chapters](#) . Within that web site, find the link to Chapters 12 - [Graphics](#) .

----- ALGEBRA in the ti 89 titanium and the hp 50 g -----

57 - **Algebra in the *ti 89 titanium***: Use the ALGEBRA menu (see item 18, above).

58 - **Algebra in the *hp 50g***: Use [↵][ALG]. In [My CALCULATORS web page](#) find the link: [HP 50G/HP 49G+/HP 48Gii User's Guide by Chapters](#) . Within that web site, find the link to Chapter 5 - [Algebraic and arithmetic operations](#). Read about the ALG menu functions in pages 5-3 and subsequent pages.

----- DIFFERENTIAL EQUATIONS in the ti 89 titanium and the hp 50 g -----

59 - **Differential equations in both calculators**: In [My CALCULATORS web page](#) find the link: [Notes on using HP & TI calculators in DYNAMICS](#) . Within that web site find the link [Solving ordinary differential equations in calculators](#). This document shows examples of solutions of ODEs in the *ti 89 titanium* as well as in the *hp 50 g* calculators.

60 - **Differential equations in the *hp 50 g***: In [My CALCULATORS web page](#) find the link: [HP 50G/HP 49G+/HP 48Gii User's Guide by Chapters](#) . Within that web site, find the link to Chapter 16 [Differential Equations](#). This chapter includes more examples in the solution of ODEs in the *hp 50 g*.

----- NUMERICAL SOLUTIONS in the *TI 89 TITANIUM* and the *hp 50 g* -----

61 - **Numerical solutions in the *ti 89 titanium*:** Press [APPS], and select the option *Numeric solution*. Press [ENTER]. Type the equation, and then press [ENTER]. For example, try: $a^2 + b^2 = 25$, [ENTER]. Then, enter $a = 3$, scroll down to b , and press [F2].

62 - **Numerical solutions in the *hp 50g*:** Press [↵][NUM.SLV][OK]. Type an equation, say, $a^2 + b^2 = 25$, and press [OK]. Type 3 into the a field, press [OK]. With the field for b selected, press [SOLVE].