RPNCalcSeries for Palm OS

Advanced Mathematics - User Guide

Version 1.0

www.rpncalcseries.com

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Introduction

• Advanced doesn't necessarily means complex. With this in mind, this calculator was made. In a very straightforward way you will deal with INTEGRALS (numeric calculation of virtually any function you want), ZERO of FUNCTIONS and FUNCTION EVALUATIONS (for single values, LISTS and GRAPHS). All is graphic and very intuitive. Besides that there is also a Math Basic calculator that deals with the following functions:

- trigonometrics;
- trigonometrics inverse;
- hyperbolics;
- hyperbolics inverse;
- natural logarithm
- decimal logarithm;
- exponential;
- pow(10, x);
- pow(y, i/x);
- sqrt;
- inverse;
- factorial

• Numerical integration and graph evaluation are performed whether a function is known explicitly or only at a finite number of equally spaced points (discrete cases). Explicitly functions are defined through a very powerful RPN based programming language. All the basic functions above mentioned and many other, as for example "Gamma" function are available trough programming. At the same time you can have up to 10 different functions defined and identified through meaningful names (refer to example 5.9). Once defined and documented, you select a function by choosing it in a list. The functions should assume x (independent variable) is in the stack X-register and y (dependent variable) is in the stack Y-register. Function values for the discrete cases f(xj), j = 1, 2, ..., n are stored by using the Function Key [B] (see item 3 below and example 5.10).

• Integrals can be finite or infinite and you can choose among Trapezoidal, Simpson, finite Gaussian-Legendre Quadrature or infinite Gaussian-Legendre Quadrature methods. Integrals solved by Gaussian Quadrature methods can use 8, 16, 32 or 64 points.

• Solution to f(x) = 0, where f(x) is a function specified by the user, is performed for continuous and real functions by using either Regula Falsi (RF) method or Newton-Raphson method. In the first case you define an interval to be searched for the root, and in the second case you define an initial "guess" for the root. A very powerful tool to help identifying an appropriate interval is the FUNCTION GRAPH or LIST.

• Basically you perform any operation you want in 3 STEPS:

- **STEP 1 -** define what you want to do **-** you do this by using the orange function keys (refer to item 3 below);
  Key [J] -> define explicit or discrete functions;
  Key [K] -> define the operation - integral, root or function evaluation;
  Key [L] -> define the method to be used. For example, for "root" operation, you have Newton or RF methods.

- **STEP 2 ->** define what you need to inform to the application in order to perform your choice defined in step 1. All is visual and the program will show only the required dark green function keys you will need to use. The function itself, whether explicit (f(x)) or discrete (f(xi)) has to be already defined. To see how, refer to the examples.

- **STEP 3** -> perform the calculation. Once steps 1 and 2 are done, just tap key [N], the red key.

• Many examples are supplied to show how powerful is this application. They show all you need, step by step.

2) Status keys

• Status Keys are 5 small rectangular keys, located below the stack display, at the right of [Addin] key. From left to right, they are referred here as [Stt0], [Stt1], [Stt2], [Stt3] and [Stt4]. The behavior of some Function Keys (see item 3) depends on the current state of the Status Keys, as described below:

- [Stt0] - displays this Help Guide

- [Stt1] - toggles between advanced (adv) and basic (bas) calculators.

- [Stt2] - toggles between degree (deg) and radian (rad) modes. When in advanced calculator, it's also used to set deg/rad mode as the desired mode.

- [Stt3] - for the basic calculator, toggles among trigonometric (trig), trigonometric inverse (trig-1), hyperbolic (hyp) and hyperbolic inverse (hyp-1) modes. These modes alter the behavior of keys [C], [D], [K] and [L], the red keys, when basic calculator is selected.

3) Function Keys

• Function Keys correspond to the 16 keys placed at the 3rd and 4th rows just below the Status Keys. Function Keys are referenced here, by an alpha ID, as described below, or by its respective icon, depending on the actual status key state:

1st row	A	B	C	D	E	F	G	H
2nd row	I	J	K	L	M	N	O	P

4) Registers

• register 00 to 09 are available to be used. Refer to Registers Documentation, by tapping [Register] key at the page footer. This key brings the "Register Documentation" screen. Registers 10 to 43 are available to store discrete function values.

5) Examples

5.0) Integral calculation

- explicit finite example - find the value of integral([0, 2*Pi] f(x) dx), being f(x)=1/(1,25-cos x).

• STEP 1 - defining what you want:
  • Keystrokes
  -> [J] - tap it, till changes to "xplt" - explicit mode
  -> [K] - tap it till changes to integral icon
  -> [L] - choose a integral calculation method. In this case, for a finite integral, it could be "trap", or "simp" or "gauss". Lets start with "trap"

• STEP 2 - defining what you need:
  • Keystrokes
  -> [f(x)] - and choose the first function in the list, labeled as "A0: example 5.0". Here we are assuming this function was already defined. Check how this function was defined by tapping [I] or [Pgm] key. You can see that the line nr 1 contains the instruction "A L0 LBL", that means Label A0, and the meaning of the next four lines, that define f(x) is:
    line 2 -> X cos Y -> is the same as Y=cosX
    line 3 -> 123 Y - Y -> is the same as Y=1.25-Y (just tap this line to see the Program Line Editor Form. "123" is a general nickname for constants. Context sensitive help is available for all screens. Just tap the small [?] button to activate it, and then tap anywhere on the screen. An on-line Programming Guide is also available. In the main screen tap [Menu] at the toolbar an choose 'Help' / ' Programming Guide'
    line 4 -> Y inv Y -> is the same as Y=1/Y
    line 5 -> STOP -> end of function definition

  -> 0 [a] - enter with integral inferior limit
  -> [Stt1] - toggle to basic (bas) calculator to evaluate 2*Pi
  -> 2 [Pi] *
  -> [Stt1] - again, to return to advanced calculator
  -> [b] - enter with integral superior limit (2xPi)
  -> 10 [n] - enter with 'n' - sub-intervals number (for Trapezoidal or Simpson)

• STEP 3 - performing the calculation - just tap [N], the red key. The result should be 8,3939, if you are using four decimals.

• Now, repeat steps 2 and 3 above for different methods and parameters. Below are some results you may find:

  - "trap" and n=16 -> 8,3778
  - "simp" and n=10 -> 8,2192
  - "simp" and n=16 -> 8,3560
  - "gauss" and g=8 -> 8,3680
  - "gauss" and g=16 -> 8,3775

- The exact result is 8 * Pi / 3 = 3,7758041

*5.1) **Integral calculation***

- other explicit finite example - find integral([1, 10] dx/x). Compare the approximations by using the same three methods used in 5.0. The exact answer is Ln(10) = 2,3025. The function definition for the integrand is under "A L1 LBL".

*5.2) **Integral calculation***

- a infinite example - find integral([0, infinite] exp(-x) * pow(x, 08) dx). This example is the integral definition for the Gamma function for x = 1.8. The next example do the same calculation by using the built-in Gamma function.

• STEP 1
 • Keystrokes
 -> [xplt]
 -> [K] - till changes to "integral" icon
 -> [L] - till changes to "gauss infinite" icon

• STEP 2
 • Keystrokes
 -> [f(x)] - choose function labeled as "A2:example 5.2 - Integral"
 -> 0 [a] - enter with integral inferior limit
 -> 16 [g]

• STEP 3 -> tap [N], the red key. The result should be 0,93137845. If you try for g = 32 or g = 64 you could get an "error 10" message. This is because, in this special case it was not possible to use 32 or 64 points, due to overflow or underflow calculation. In such situations try using a smaller number of points for Gaussian Quadrature. Anyway, the exact result is 0,93138371

5.3)Function Evaluation

- Calculate the same value (Gamma(1,8)), by using the built-in operation 'Gamma':

• Keystrokes
 -> [F] - choose the function in the list. In the actual example, choose "B0:Gamma(I)-Built-in"
 -> 1,8 [N] - compute Gamma(1,8). The result should be 0,93138371. Notice that the error is less than 3,7*pow(10, -7) as stated in the Operations Guide (refer to [2][1][9][0]).

*5.4) **Integral calculation***

- infinite integral calculation - Normal or Gaussian Probability function is defined as Q(x) = 1/sqrt(2*Pi)*Integral([x, infinite], exp(-t*t/2)), where the integrand is known as the Normal Density function. The Normal Density function is defined under LBL A4, without the constant 1/sqrt(2*Pi).

5.4.1) Calculate the Normal Integral for x = 1.18

• STEP 1

• Keystrokes
-> [xplt]
-> [K] - till changes to "integral" icon
-> [L] - till changes to "gauss infinite" icon

• STEP 2
• Keystrokes
-> [f(x)] - choose function labeled as "A4:example 5.4 - Integral"
-> 1.18 [a] - enter with integral inferior limit
-> 32 [g]

• STEP 3 -> tap [N]. The result should be 0.298289. Multiplying this result by 0.398942 (1/sqrt(2*Pi)) the final result will be 0.119000

5.4.2) Function evaluation - Plotting a graph - now for the same Normal Density function plot a graph in the interval [-2.00, +2.00]:

• STEP 1
• Keystrokes
-> [xplt]
-> [K] - till changes to "fx" icon
-> [L] - till changes to "graph" icon
-> [M] - check that the [xInterval] is properly set.

• STEP 2 - it was already done in the previous example

• STEP 3 -> tap [N]. The graph will be plotted

5.5) ***Root calculation***

- Find an angle alpha between 100 and 101 radians, such that sin(alpha) = 0.1. Hence let f(x) = sin(x) - 0.1, already defined under A LBL L5:

• STEP 1
• Keystrokes
-> [xplt]
-> [Stt1] – till changes to “rad”
-> [K] - till changes to "root" icon
-> [L] - till changes to "RF" icon

• STEP 2
• Keystrokes
-> [f(x)] - choose function labeled as "A5:example 5.5 - root"
-> 100 [a] - enter with interval inferior limit
-> 101 [b] - ditto for superior limit
-> 10 [i] - number maximum of iterations

• STEP 3 -> tap [N] the result should be 100.6311. If you want to know how many iterations were necessary, tap [RCL] 81. The value would be 4. The accuracy of precision depends on the amount of decimals you are using. The precision is higher when increasing the decimals.

- Repeat this exercise for Newton method, using 100 as a 'guess'. The result should be also 100.6311. Tap [RCL] 81 to display 3 as the number of iterations.

5.6) Root Calculation

- Find a root of the equation Ln(x) + 3*x - 10.8074 = 0. This function is defined under A LBL L6. Repeat the steps from the previous exercise for Newton method, giving for example 1.0 as a 'guess'. You should find 3.213360 as the result.

5.7) Integral calculation - a discrete example

- given the values below for f(xj), j=0, 1, ..., 8, compute the approximations to the integral:
  integral([0, 2], f(x) dx),
by the trapezoidal rule and by Simpson's rule.

- the values to be entered are:
  a=0
  b=2
  n=8 (sub-intervals number) and

j	xj	f(xj)
0	0.00	2.0
1	0.25	2.8
2	0.50	3.8
3	0.75	5.2
4	1.00	7.0
5	1.25	9.2
6	1.50	12.1
7	1.75	15.6
8	2.00	20.0

• STEP 1
  • Keystrokes
  -> [disc] - for discrete mode
  -> [K] - till changes to "integral" icon
  -> [L] - till changes to "trap" icon

• STEP 2
  • Keystrokes
  -> [P] - to clear discrete values
  -> 0 [a] - enter with interval inferior limit
  -> 2 [b] - ditto for superior limit
  -> 8 [n] - enter with the number of sub-intervals
  -> 2 [f(Xi)] - f(x0)
  -> 2.8 [f(Xi)] - f(x1)
  -> 3.8 [f(Xi)] - f(x2)
  -> 5.2 [f(Xi)] - f(x3)
  -> 7 [f(Xi)] - f(x4)
  -> 9.2 [f(Xi)] - f(x5)
  -> 12.1 [f(Xi)] - f(x6)

-> 15.6 [f(Xi)] - f(x7)
-> 20 [f(Xi)] - f(x8)

• STEP 3 -> tap [N] the result should be 16.675.

- Change now for Simpson ("simp") method an recalculate the integral. The new value should be 16.5833
- Plot now a graph by tapping key [K] till displays "fx" icon. Tap [L] till shows the "graph" icon, and then tap [N], the red key. The graph will be plotted.

5.8) Generating a printable Calculator Documentation

- to generate printable documentation, proceed as follows:

a) generate Palm Memo records by using the facility [Doc] in the Addin Manager Screen. Just tap [Addin] at the calculator main screen and then tap [Doc]. A complete set of program documentation will be generated in the Palm Memo database under the name "Math: Advanced".
b) launch Palm Desktop;
c) in Memo view, select the record generated in a), click with the right mouse button and choose "send to" / "MS Word".

5.9) Defining or modifying a FUNCTION LABEL

- 10 user function labels are available to define functions. To create or modify a label do:

- tap [Pgm] purple key. Program Lines screen will appear. This is the screen that shows the lines of code you written. Context sensitive help is available. To activate it, just tap the button [?] at the right superior corner of the screen, an then tap anywhere on the screen;
- tap the popup trigger named "Doc" at the left of the help button [?];
-choose 'Labels'. A new screen will be displayed - the Label Manager screen;
- check to see you have 10 labels already defined. Label names must start with letter "A", followed by a number from 0 to 9 and a ":" character. After ":" you can write the text you want. Labels that don't follow these rules will not appear in the list of functions to be chosen for calculator operations. They also have to conform to the respective label being used in the Programming Lines screen;
- to modify an existing label, select it and tap [Mod]. Once modified, tap [OK] or [Mod] to accept the modification or any other key to cancel.
- tap [OK] to leave the Label Manager screen and [OK] again to leave Program Lines screen and return to Main screen.

5.10) How to store or recall discrete function values

- [Stt1] key to switch to advanced calculator ("adv");
- to clean all the values, tap the key [P];
- tap [J], the first orange key, from left to right, till "disc" displays;

- now you can sequentially enter with discrete values. Refer to example 5.7 to see how. You have up to 34 registers available to define discrete functions. At any time you can check these values:
  - tap [help] status key
  - tap [Registers] at the bottom of the new screen
  - tap [1] at the top of the screen
  - tap [Show All] at the bottom of the screen. Now you are seeing the first 10 discrete values. To go to the next 10, tap [2] at the top of the screen;
  - tap [OK] to return to help screen;
  - tap [Exit] to return to main screen

- if you want to recall a specific discrete value, when in the main screen, enter with the discrete value order you want in the X stack register and then tap [RCL] [f(xi)].

- if you want to store a specific discrete value, overwriting a already stored value, proceed as in the example below:

  - to store 10 at the position 5, do:
    - 10 [Enter] 5 [STO] [f(xi)]

6) Error codes

- Sometimes, depending on the operation involved, you can get an error condition. In such cases an error code will be displayed, meaning:

- error 00 - a mathematics error, for example division by zero;

- error 01 - overflow or underflow error. This will happen when the result is greater than pow(10, 99) or lower than pow(10, -99);

- error10 - when some advanced mathematics operations you could get this error code. For example, if you finding a root and the maximum iteration value you set is not enough, you will get this error code. Another example is when finding integrals by using Gaussian Quadrature you also can get an "erro10" message.

■ Full registration details for this software you can find on Handango at http://www.handango.com/