

Equation System Solver

USER'S MANUAL

I developed this program to have an easier to use interface to solve Systems of Equations, both linear and nonlinear. It uses the function SOLVE to find the solutions of said systems.

Installation

Copy the library to your calculator's SD card. Enter FILES and copy it to Port 0 or Port 1. Press and hold ON+F3 to perform a warmstart. Go to Lib and you will see the program.

To familiarize with it let's solve the next system:

$$\begin{cases} S_1 - 3W_7 = 8 \\ \frac{S_1}{W_7} = 22 \end{cases}$$

The use is very straightforward. When you run the library you get a splash screen with the name of the program and the author:

```
*****  
SYSTEM OF EQUATIONS  
SOLVER  
Ing. Sergio Matus  
*****  
BBPAR L1555 L1301 INPUT EqSv3 ESSOL
```

Press any key, except ON (it will quit the program) to start entering data.

1. First enter the quantity of equations that form the system. In this case the number is 2.

```
RAD XYZ HEX R= 'X' PRG  
<HOME>  
Input the number of  
equations that form  
the system  
  
:#Equations=:2  
VLST ECS BBPAR L1555 L1301 INPUT
```

Press enter after specifying the value.

2. You will get a screen like this:

A screenshot of a terminal window titled "EQUATION #1". The prompt "Eq=" is followed by a black rectangular input field. Below the input field, the text "Input the equation, use ' '" is displayed. At the bottom, there is a row of buttons: "EDIT", three empty square buttons, "CANCL", and "OK".

It tells you the number of the equation you're about to enter. In the space reserved for it enter the equation. Do this using the Equation Writer or simply put the equation inside apostrophes (') as indicated on the bottom of the input form. Enter and press OK.

A screenshot of the "EQUATION #1" screen. The input field now contains the text "'S1-3*W7=8'". The rest of the screen, including the prompt and the bottom buttons, is identical to the previous screenshot.

A screenshot of a terminal window titled "EQUATION #2". The prompt "Eq=" is followed by a black rectangular input field containing the text "'S1/W7=22'". Below the input field, the text "Input the equation, use ' '" is displayed. At the bottom, there is a row of buttons: "EDIT", three empty square buttons, "CANCL", and "OK".

After you enter the last equation, if the number of unknowns is equal to the number of equations in the system you get the results:

A screenshot of a terminal window showing the results of solving a system of equations. The title bar reads "RAD XYZ HEX R= 'X'". The main content area shows a list of equations and their solution. The equations are listed on the left, and the solution is shown on the right. The equations are: "4:", "3:", "2:", and "1:". The solution is shown as a boxed expression:
$$\left[S1 = \frac{176}{19} \quad W7 = \frac{8}{19} \right]$$
. At the bottom, there is a row of buttons: "OBJ+", "+ARRY", "+LIST", "+STR", "+TAG", and "+UNIT".

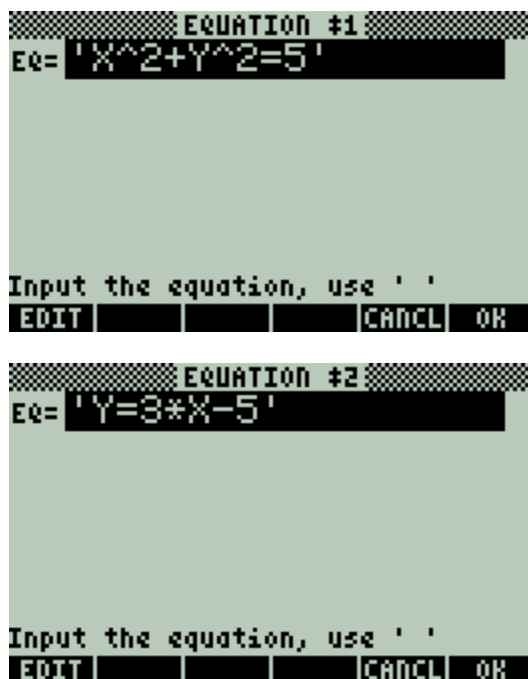
Notice on the stack you get the equations that you entered and as many answers as the system has, in this example only one. Also the program leaves you in the TYPE menu in case you need to extract values from the answer vectors.

Example 2

Let's solve a nonlinear system

$$\begin{cases} x^2 + y^2 = 5 \\ y = 3x - 5 \end{cases}$$

Enter the program and the equations



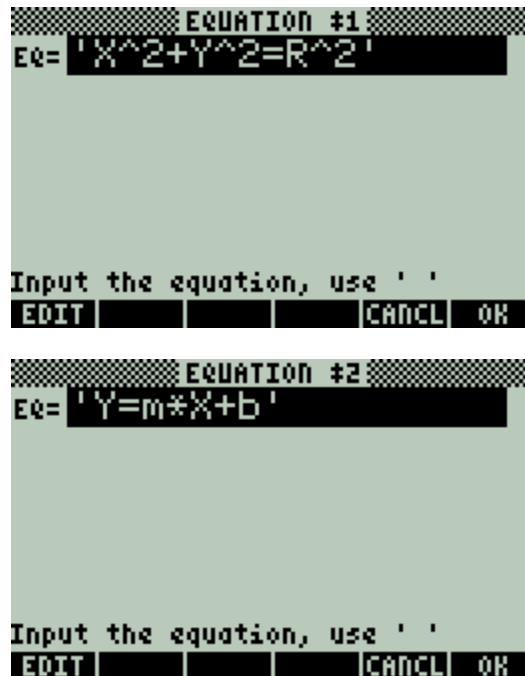
After you enter the last equations results are shown on the stack. As you can see we now have a pair of answers, both satisfy every equation of the system.



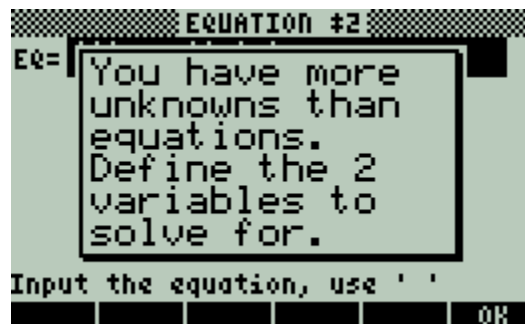
In these first 2 examples we had 2 equations and 2 variables, so the calculator solved directly for the detected variables. Let's see what happens when you have more unknowns than equations.

Example 3

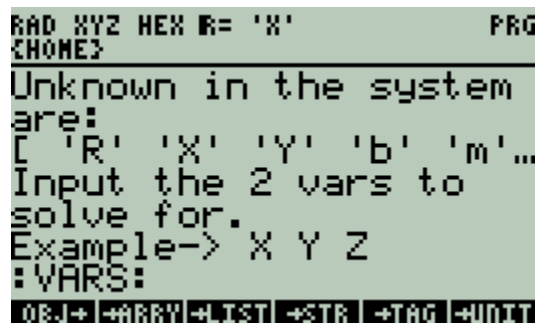
Find a general solution for the intersection of a circle with center at the origin and radius R and a line $Y=mX+b$



We have 2 equations and 5 unknowns, so we get this message



Press OK. You will now be asked to define the 2 variables (because there are 2 equations) to solve for, the others will be considered constants.



In this case, I will solve for X and Y, but I can choose any two of the five as variables. Alpha-lock is on so you just have to type: X Y

```

RAD XYZ HEX R= 'X'          PRG
{HOME}
Unknown in the system
are:
[ 'R' 'X' 'Y' 'b' 'm'...
Input the 2 vars to
solve for.
Example-> X Y Z
:VARS:X Y
OBJ+ →ARRY →LIST →STR →TAG →UNIT

```

And press ENTER. Now the results are on the stack, this is a screenshot:

```

RAD XYZ HEX R= 'X'          PRG
{HOME}
2: [ X=- (b*m-√(R^2*m^2-(b^2-R^2))) / (m^2+1)
1: [ X=- (b*m+√(R^2*m^2-(b^2-R^2))) / (m^2+1)
OBJ+ →ARRY →LIST →STR →TAG →UNIT

```

Press UP arrow and you will see this

```

RAD XYZ HEX R= 'X'          PRG
{HOME}
7:
6:
5:
4:      'X^2+Y^2=R^2'
3:      'Y=m*X+b'
2: [ 'X=-((b*m-√(R^2*m^2-(b^2-R^2))))/(m^2+1)
1▶ [ 'X=-((b*m+√(R^2*m^2-(b^2-R^2))))/(m^2+1)
ECHO VIEW EDIT PICK ROLL ROLLO

```

Lines 3 and 4 of the stack are the equations we entered, lines 1 and 2 are solutions. If we press VIEW of the TOOL menu we can see each one more clearly.

```

RAD XYZ HEX R= 'X'          PRG
{HOME}
7:
6:
5:
4:      'X^2+Y^2=R^2'
3:      'Y=m*X+b'
2: [ 'X=-((b*m-√(R^2*m^2-(b^2-R^2))))/(m^2+1)
1▶ [ 'X=-((b*m+√(R^2*m^2-(b^2-R^2))))/(m^2+1)
ECHO VIEW EDIT PICK ROLL ROLLO

```

That's the solution, but we can use other calculator functions to determine the value of R in function of m so that X and Y are real numbers.

The calculator screen shows the following expressions:

2:
$$Y = \frac{-b + m \cdot \sqrt{R^2 \cdot m^2 - (b^2 - R^2)}}{m^2 + 1}$$

1:
$$R = \frac{|b|}{|m^2 + 1|} \cdot \sqrt{m^2 + 1}$$

At the bottom, the menu options are: DESOL, ISOL, LDEC, LINSO, SOLVE, SOLVE.

Notice

Some systems don't have solutions, in that case on the stack only the equations will appear.

As I said at the start of this document the solutions are found using the SOLVE function. One disadvantage is that if the system is not exact (presence of decimals) the solver will not give an answer, even if it exists. In these cases the program will find a numeric solution.

Example 4

$$\begin{cases} 0.05x - 0.03y = 0.21 \\ 0.07x + 0.02y = 0.16 \end{cases}$$

To solve we have 2 options.

- 1) Enter it the way it is

The calculator screen shows the input of two equations:

EQUATION #1.
Eq= '.05*X-.03*Y=.21'

Input the equation, use ' '
EDIT [] [] [] [] CANCL OK

EQUATION #2.
Eq= '.07*X+.02*Y=.16'

Input the equation, use ' '
EDIT [] [] [] [] CANCL OK

EQUATION #2

EQ= '.07*X+.02*Y=.16'

Approx. mode on?

YES

no

Input the equation, use ' '

CANCEL OK

```

RAD XYZ HEX R= 'X'                                PRG
(CHOME)
This is not an exact
system. Provide seed
values for these
variables:
[ 'X' 'Y' ]
Example: 1 1
:Seed values:
OBJ+ +ARRY+LIST+STR+TAG+UNIT

```

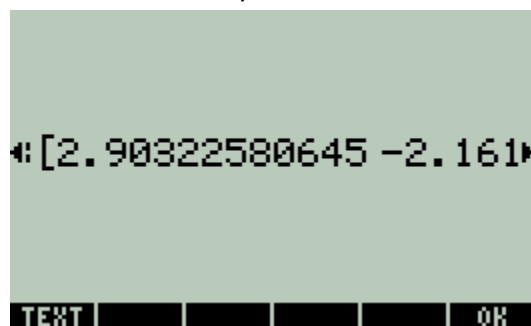
```
RAD XYZ HEX R= 'X' PRG
(CHOME)
This is not an exact
system. Provide seed
values for these
variables:
[ 'X' 'Y' ]
Example: 1 1
:Seed values:20 15
OBJ+ +ARRY+LIST+STR+TAG+UNIT
```

```

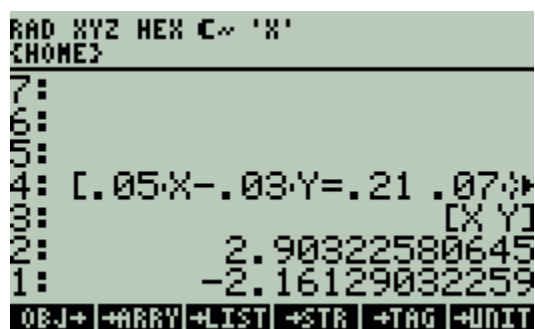
RAD XYZ HEX C~ 'X'
{HOME}
7:
6:
5:
4:
3: [1.05X-.03Y=.21 .070]
2: [X Y]
1: Solutions::[2.90322]
EDIT VIEW STACK RCL PURGE CLEAR

```

Press TOOL VIEW to scroll the answer easily:



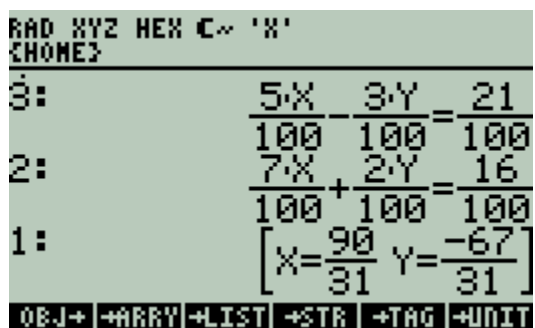
Or use OBJ \square OBJ \square to see it as below



2) Make the system exact substituting the decimal numbers by equivalent fractions

$$\begin{cases} \frac{5}{100}x - \frac{3}{100}y = \frac{21}{100} \\ \frac{7}{100}x + \frac{2}{100}y = \frac{16}{100} \end{cases}$$

Follow the usual steps and the answer will be:



I hope this program serves you well.

One last thing. I'm a civil engineer and I like to program utilities like this, if you have an interesting project that you want to develop I would like to help you, particularly in the field of structural engineering. Contact me at **smmpbkp1@gmail.com**