Solving Equations on the TI-89 Graphing Calculator

Solving equations is something every engineering student must know how to do. Doing the algebra by hand to solve is way too time consuming to do on an exam and when you're trying to work long homework assignments. We can save lots of time and prevent algebra mistakes by using the TI-89 to solve equations for us.

Exact or Approximate:

Before we get started with solving equations you might want to change the setting that determines what kind of results are displayed.

**Exact** – gives results in fraction form or with the square root operator

Approximate – gives an approximation of the result. This answer will be in the form of a whole or floating point number

Most of the time it's easier to use the approximation mode – that's what I use most of the time.

To change the mode: hit the **MODE** button and page down until you see Exact/Approx. Right arrow to see the options. There are options for 1: Auto (it'll display results in exact or approx. mode based on the number, 2: Exact, 3: Approximate.

Solving for Real Roots of an Equation:

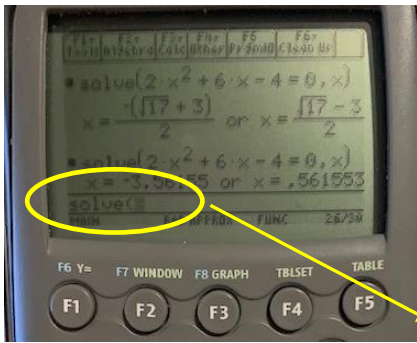Hit the following buttons to get to the **solve()** function:
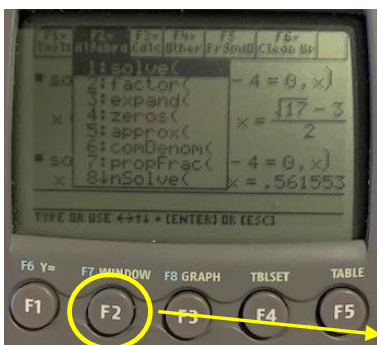
F2 takes you to the Algebra menu
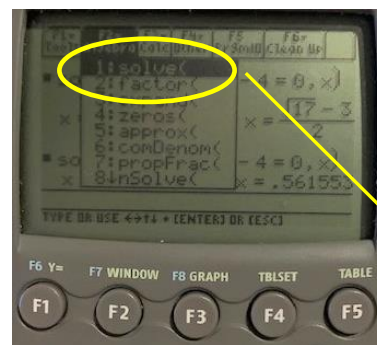
hit enter on option 1

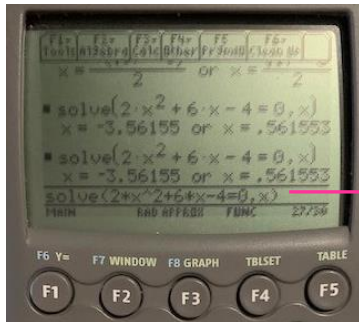Syntax for the solve function is: **solve(equation, variable you're solving for)**
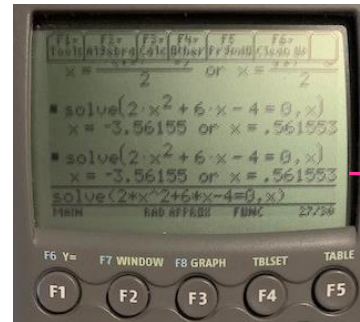
Now you can type the equation

Examples:

1. Solve the equation $2x^2 + 6x - 4 = 0$

    On TI-89 use: solve(2x^2+6x-4=0,x)

    Result: -3.56155, 0.561553   Note: these would be the same values you'd get from using the quadratic equation.
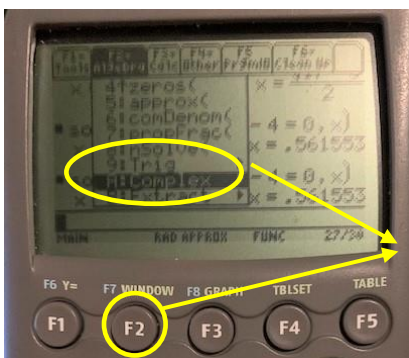

What you type
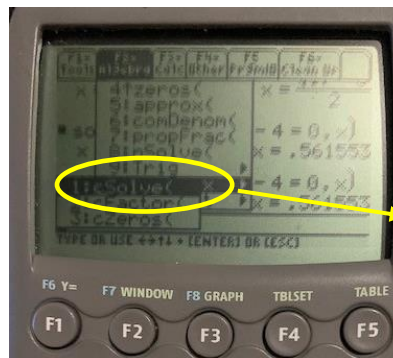

results

2. Solve the equation $4x^2 - 8x + 6 = 0$

    On the TI-89 use: solve(4x^2-8x+6=0,x)

    Result: false

The false result means the roots aren't real, instead, they are complex. For this case you need to use the **csolve** function. Csolve is found in the Algebra menu just like the solve function. Do the following to find it:

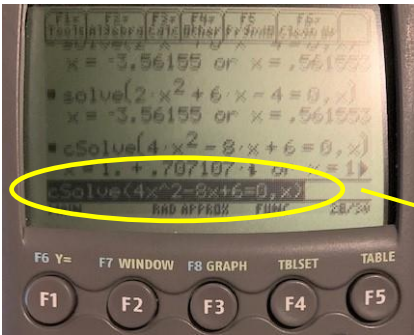Hit F2 and then hit the up arrow to find A:Complex

Right arrow to see the options.
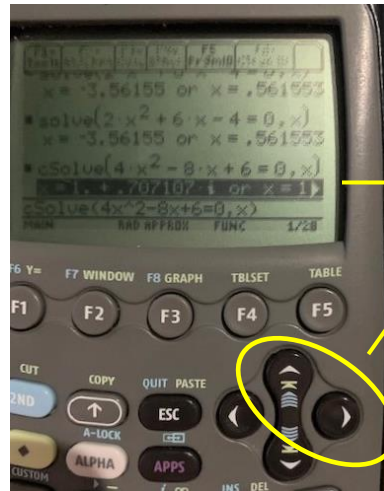
Select option 1 for csolve(

3. Solve the equation $4x^2 - 8x + 6 = 0$

    On the TI-89 use: csolve(4x^2-8x+6=0,x)

Result: x=1+.707107i, 1-.707107i

Type this

Up arrow to highlight result. Then use right arrow and scroll right to see rest of result
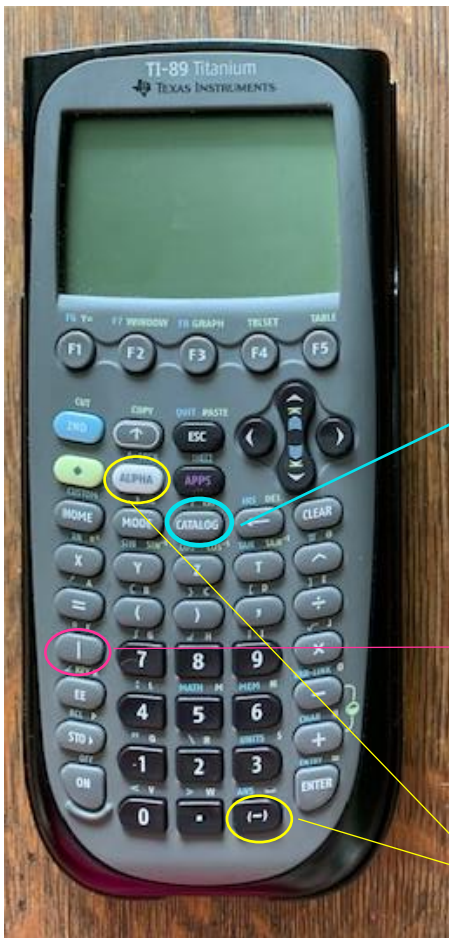
Including 'and'

If you need to add and into your statement you can do that too. This can be used to limit x values for example.

4. Find the real roots of $\cos(x) = x^3$ between 0 and π.

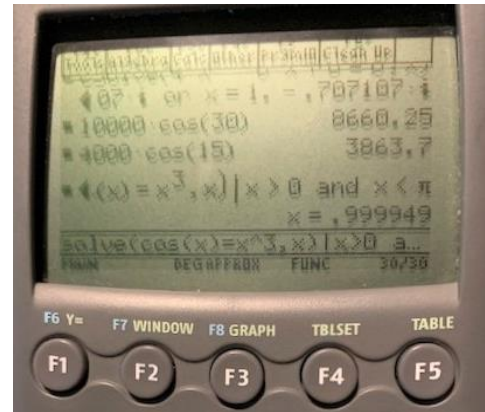On the TI-89 use: solve(cos(x)=x^3,x)|x>0 and x< π See below where to find |, space, and

Result: 0.999949

'and' can be found in the catalog – just scroll until you find 'and' or you can simply type in 'and' using the alpha key and the = 6 , buttons

| button

Use ALPHA and (-) button to get a space

Solving Systems of Equations

We have a few different ways to solve systems of equations. Mastering these will save you a ton of time especially if you're in a class that has lots of systems of equations like Statics or System Dynamics. You definitely don't want to do all that solving by hand. The cool thing about the TI-89 is that you can also use variables instead of numbers. This means if you get one of those problems with no numbers, just variables, you can still solve using the calculator. Let's get started!
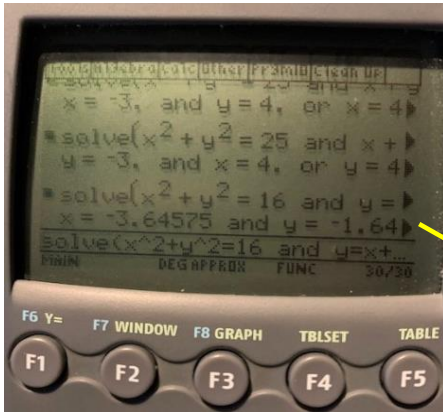
Using solve()

We used this function before but now we will change it up a little bit so we can solve a system of equations.

5. Solve the following system of equations to see where the line intersects the circle. Circle: $x^2 + y^2 = 16$
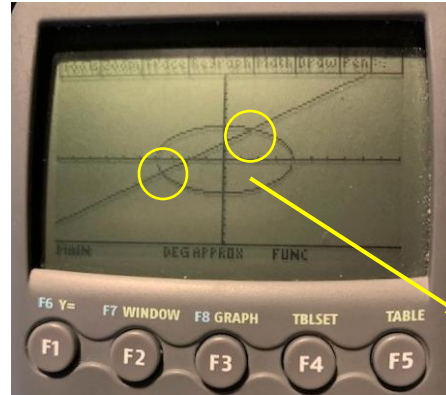
   Line: $y = x + 2$

   On the TI-89 use: solve(x^2+y^2=16 and y=x+2,x) Note: you could also use the variable y instead of the x

   Result: x=-3.64575 and y=-1.64575, x=1.64575 and y=3.64575

Up arrow and scroll right to see complete results

If you plot the functions, you can see they intersect at the coordinates given in the results

Using simult()

This is a function made just for solving systems of equations simultaneously. This one essentially puts the equations in matrix form and uses that info to solve. The way to use simult() is:

simult([matrix of coefficients],[vector of right hand side coefficients])

The easiest way to find the function is to just type simult. To save time typing the letters, use alpha lock. To turn on alpha lock simply hit the 2ND button before hitting ALPHA. Once you're done typing simult, hit alpha again.

6. Solve the system of equations

25x-2y+0z=1

-2x+45y-15z=-17

7x-15y+4z=-8

Note: variables in the equations need to be in the same order. Notice how in this system the variables are always in x y z order. Also, there has to be the same number of terms in each equation. So, if your equations have different numbers of terms you'll have to add in zero coefficients. Notice in this example the z term in the first equation has a zero coefficient.

To create the matrix of coefficients use [[25,-2,0][-2,45,-15][7,-15,4]]

Inner brackets indicate new row/equation in the matrix

Outer brackets create the matrix

On the TI-89 use: simult([[25,-2,0][-2,45,-15][7,-15,4]],[[1][-17][-8]])

Result: $\begin{bmatrix} .452202 \\ 5.15252 \\ 16.5306 \end{bmatrix}$ This tells us that x=0.452202, y=5.15252, z=16.5306.

Note: the order of the results follows the order of variables in the equations. For example, if you had a system of equations in the order z x y, the results would be in z x y order as well.

Results
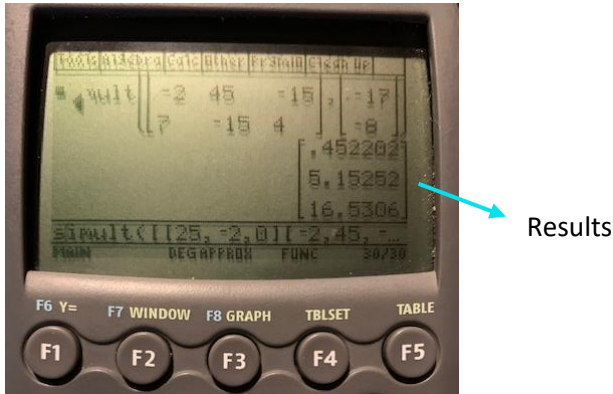
Using matrices

This is the method I use because I think it's the easiest. It uses the $Ax = b$ concept from linear algebra. A is the coefficient matrix from your equations just like we had on the last method. b is a column vector that contains the values from the right hand side of the equations. x is a column vector that contains the unknowns.

Let's look at the last example again.

7. Solve the system of equations

    25x-2y+0z=1

    -2x+45y-15z=-17

    7x-15y+4z=-8

$$\text{Let A=}\begin{bmatrix} 25 & -2 & 0 \\ -2 & 45 & -15 \\ 7 & -15 & 4 \end{bmatrix} \quad b = \begin{bmatrix} 1 \\ -17 \\ -8 \end{bmatrix} \quad x = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

To solve the system we need to do the following math operation: $x = A^{-1}b$. We're going to take the inverse of A and multiply it by b.
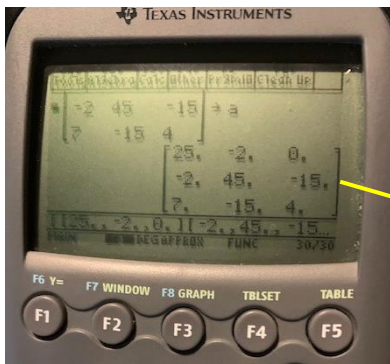
On the TI-89 use:

    Step 1: [[25 -2 0][-2 45 -15][7 -15 4]] ENTER   (gives the A matrix)

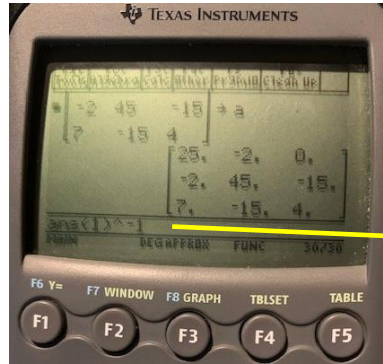   Step 2: ^-1   This takes the inverse of A. Note: once you hit the ^ ans will appear at the cursor.

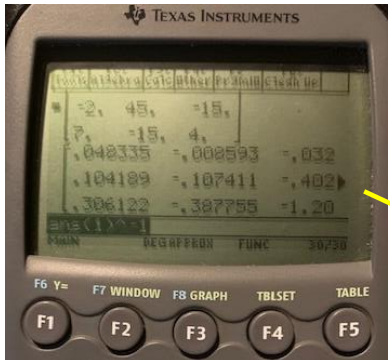   Step 3: *[[1][-17][-8]]   This multiplies the result from step 2 by the b matrix.

$$\text{Result: }\begin{bmatrix} .452202 \\ 5.15252 \\ 16.5306 \end{bmatrix}\quad \text{Notice this is the same thing you got in the last example.}$$
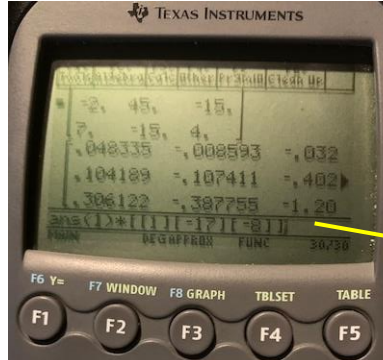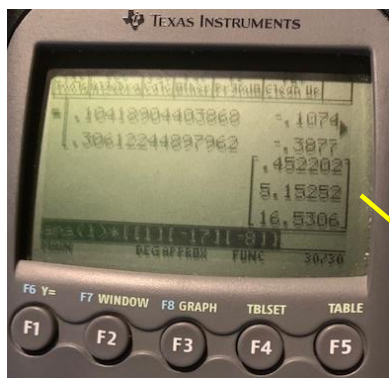
A matrix

Take inverse of A

A^{-1}

Multiply by b matrix

Result of $A^{-1}b$

This tells us that x=0.452202, y=5.15252, z=16.5306.

Using symbols in the calculations

You've probably had your fair share of problems where you have to include a variable in your calculations. These problems can cause some students problems because of the algebra involved. Good news is the TI-89 can do calculations with symbols.

You can use the standard letters of the alphabet or you can use the Greek letters. To get to the Greek letters go to the character menu. Hit the following 3 buttons to get there: 2ND + 1. Now that you know how to find the Greek letters let's look at an example.

8. Solve the following system of equations in terms of the Greek letter alpha, α.
   $(3\alpha)x - 2y=10$
   $5x+(7\alpha)y=8$
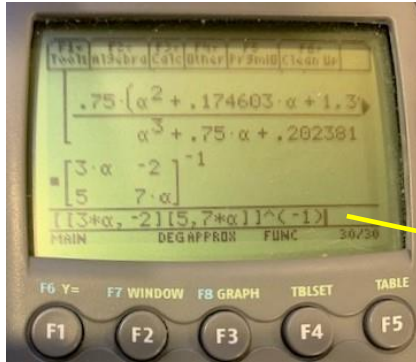
   On the TI-89 use:

   Step 1: $[[3*\alpha, -2][5,7*\alpha]]^{} - 1$ Create the A matrix using the alpha symbol and then find the inverse. Note: you don't have to put the multiply sign in before the α
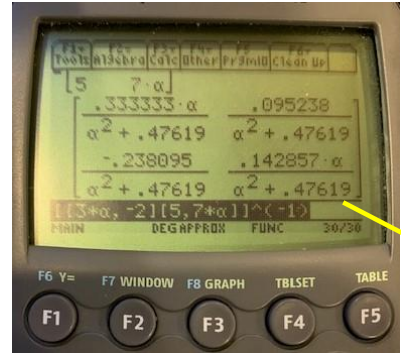
Step 2: *[[10][8]]   Multiply the result of step 1 by matrix b

Result: $\begin{bmatrix} \dfrac{3.33333(\alpha+.228571)}{\alpha^2+.47619} \\ \dfrac{1.14286(\alpha-2.08333)}{\alpha^2+.47619} \end{bmatrix}$ Notice how the result is a function of the symbol α
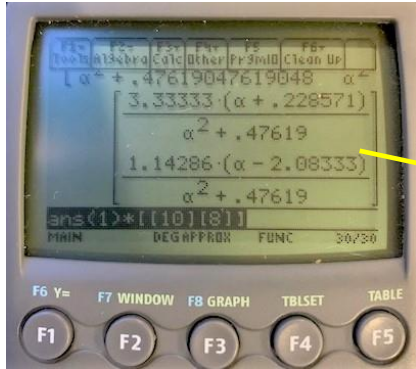

Find the inverse of the A matrix

A^{-1}

Result:

x = top fraction

y = bottom fraction