

## Solving simultaneous equations.

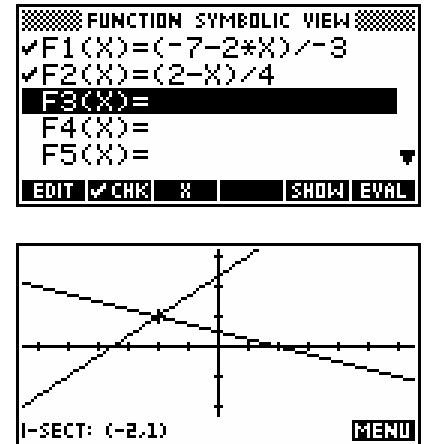
Solve the systems of equations below:

$$(i) \quad \left. \begin{aligned} 2x - 3y &= -7 \\ x + 4y &= 2 \end{aligned} \right\} \quad (ii) \quad \begin{aligned} 2x - y &= 4 \\ -3x + 2y - z &= -10.5 \\ x - 3y + z &= 10.5 \end{aligned}$$

### Method 1 - Graphing the lines

Because the first set of equations is a 2x2 system it can be graphed in the Function applet. To do this it is necessary to re-arrange the functions into the form  $y = \dots$  and store them into F1(X) and F2(X) in the SYMB view of the Function applet. Switch to the PLOT view and use the **FCN** Intersection tool to find the point of intersection.

It is worth noting that although the point of intersection is on the screen here, this is not necessary. The **FCN** Intersection tool will work even if neither line is visible on the currently set axes.



### Method 2 - Using a matrix

Step 1. Rewrite  $\left. \begin{aligned} 2x - 3y &= -7 \\ x + 4y &= 2 \end{aligned} \right\}$  as  $\begin{bmatrix} 2 & -3 \\ 1 & 4 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} -7 \\ 2 \end{bmatrix}$

This means that  $\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 2 & -3 \\ 1 & 4 \end{bmatrix}^{-1} \times \begin{bmatrix} -7 \\ 2 \end{bmatrix}$

Step 2. Switch into the Matrix Catalog (SHIFT MATRIX). Position the highlight on M1 and press **EDIT**. Enter the matrix shown right.

Press SHIFT MATRIX to change back to the catalog view and create M2 as shown below right. Note that setting **GO↓** will make it easier to enter M2.

M1	1	2		
$\frac{1}{2}$	2	-3		
$\frac{1}{1}$	1	4		
2				
EDIT   INS   GO↓   BIG				
M2	1			
$\frac{1}{2}$	-7			
$\frac{1}{1}$	2			
EDIT   INS   GO↓   BIG				

Step 3. Change into the HOME view and enter the calculation  $M1^{-1} * M2$ . The result is the (x,y) coordinate of the solution displayed as a matrix.



M1	1	2	3	
1	2	-1	0	
2	-3	2	-1	
3	1	-3	1	

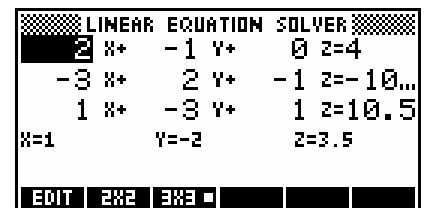
Calculator screen showing the matrix M1. The screen displays "M1" and the matrix  $\begin{bmatrix} 1 & 2 & -1 & 0 \\ 2 & -3 & 2 & -1 \\ 3 & 1 & -3 & 1 \end{bmatrix}$ . The bottom of the screen shows "EDIT INS GO+ BIG".

A similar method can be used to solve the second 3x3 system of equations. The matrix M1 and the result are shown right.



### Method 3 - Using the Linear Solver aplet

This method uses an aplet called the Linear Solver which was added into the new hp 39gs and hp 40gs. For earlier models there is a similar aplet available from the internet called the "Simult 3x3" aplet.



It allows easy solution of 2x2 and 3x3 systems of linear equations in a format which is more user friendly than the use of matrices for student who are not familiar with them. The disadvantage is that it shows no working.

Note: If your simultaneous linear equations have algebraic coefficients then you will not be able to use any of the above methods because they will all substitute the current value for the coefficients rather than assuming they are symbolic. If you are fortunate enough to own an hp 40gs rather than an hp 39gs then you can use the CAS for this.