How to solve simultaneous linear equations

There are three ways (in order of increasing difficulty)

METHOD (1): Using the "simultaneous equations" app on your TI calculator.

METHOD (2): Using the matrix inverse operation on your calculator.

METHOD (3): Using Cramer's Method.

Method (1) Your TI calculator must have the simultaneous equation app installed on it. The app prompts for all the coefficients of the standard form and then gives you the solution.

[A|b]

eg Std form $3I_1 + 4I_2 + 5I_3 = 7$

$I_1 + 2I_2 + 3I_3 = 2$

$2I_1 - I_2 + 6I_3 = 0$

You type in these 12 numbers, and the calculator tells you that $I_1 = 2.35\,A$

$I_2 = 0.8\,A$

$I_3 = -0.65\,A$.

Method (2) Using Matrix inverse function

Std. form:

$$\begin{aligned} 3I_1 + 4I_2 + 5I_3 &= 7 \\ I_1 + 2I_2 + 3I_3 &= 2 \\ 2I_1 - I_2 + 6I_3 &= 0 \end{aligned}$$

$$\Rightarrow \underbrace{\begin{bmatrix} 3 & 4 & 5 \\ 1 & 2 & 3 \\ 2 & -1 & 6 \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}}_{\underline{X}} = \underbrace{\begin{bmatrix} 7 \\ 2 \\ 0 \end{bmatrix}}_{\underline{B}}$$ matrix form

$$\Rightarrow A\,\underline{X} = \underline{B}$$

$$\Rightarrow \underline{X} = A^{-1}\,\underline{B}$$

$$\underline{X} = \begin{bmatrix} 3 & 4 & 5 \\ 1 & 2 & 3 \\ 2 & -1 & 6 \end{bmatrix}^{-1} \begin{bmatrix} 7 \\ 2 \\ 0 \end{bmatrix}$$

$$= \begin{bmatrix} .75 & -1.45 & .1 \\ 0 & .4 & -.2 \\ -.25 & .55 & .1 \end{bmatrix} \begin{bmatrix} 7 \\ 2 \\ 0 \end{bmatrix}$$ (calculated A^{-1} using calculator matrix inverse function)

$$= \begin{bmatrix} 2.35 \\ 0.8 \\ -0.65 \end{bmatrix}$$ so $\begin{cases} I_1 = 2.35\,A \\ I_2 = 0.8\,A \\ I_3 = -0.65\,A \end{cases}$

Method (3) Cramer's Rule

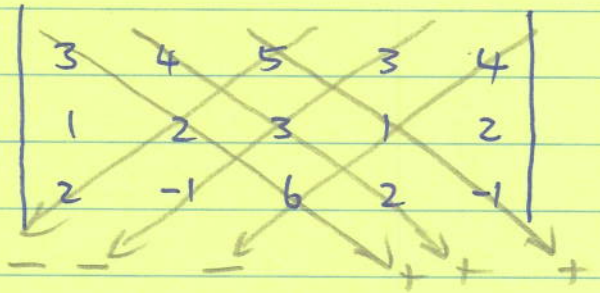
see Dr. Shareef's notes on Cramer's Rule.

Std form:

$$\begin{aligned} 3I_1 + 4I_2 + 5I_3 &= 7 \\ I_1 + 2I_2 + 3I_3 &= 2 \\ 2I_1 - I_2 + 6I_3 &= 0 \end{aligned}$$

$$\underbrace{\begin{bmatrix} 3 & 4 & 5 \\ 1 & 2 & 3 \\ 2 & -1 & 6 \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}}_{X} = \underbrace{\begin{bmatrix} 7 \\ 2 \\ 0 \end{bmatrix}}_{B}$$

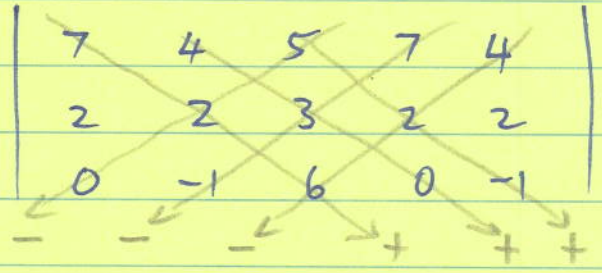
$$\Delta = |A| = \begin{vmatrix} 3 & 4 & 5 \\ 1 & 2 & 3 \\ 2 & -1 & 6 \end{vmatrix} = \begin{vmatrix} 3 & 4 & 5 & 3 & 4 \\ 1 & 2 & 3 & 1 & 2 \\ 2 & -1 & 6 & 2 & -1 \end{vmatrix}$$



$$= 3(2)6 + 4(3)2 + 5(1)(-1) - 5(2)2 - 3(3)(-1) - 4(1)6$$

$$= 36 + 24 - 5 - 20 + 9 - 24 = 20$$

$$\Delta_1 = \begin{vmatrix} 7 & 4 & 5 \\ 2 & 2 & 3 \\ 0 & -1 & 6 \end{vmatrix} = \begin{vmatrix} 7 & 4 & 5 & 7 & 4 \\ 2 & 2 & 3 & 2 & 2 \\ 0 & -1 & 6 & 0 & -1 \end{vmatrix}$$



$$= 7(2)6 + 4(3)0 + 5(2)(-1) - 5(2)0 - 7(3)(-1) - 4(2)6$$

$$= 84 + 0 - 10 - 0 + 21 - 48 = 47$$

$$\Delta_2 = \begin{vmatrix} 3 & 7 & 5 \\ 1 & 2 & 3 \\ 2 & 0 & 6 \end{vmatrix} = \begin{vmatrix} 3 & 7 & 5 & 3 & 7 \\ 1 & 2 & 3 & 1 & 2 \\ 2 & 0 & 6 & 2 & 0 \end{vmatrix}$$

$$= 3(2)6 + 7(3)2 + 5(1)0 - 5(2)2 - 3(3)0 - 7(1)6$$

$$= 36 + 42 + 0 - 20 - 0 - 42 = 16.$$

$$\Delta_3 = \begin{vmatrix} 3 & 4 & 7 \\ 1 & 2 & 2 \\ 2 & -1 & 0 \end{vmatrix} = \begin{vmatrix} 3 & 4 & 7 & 3 & 4 \\ 1 & 2 & 2 & 1 & 2 \\ 2 & -1 & 0 & 2 & -1 \end{vmatrix}$$

$$= 3(2)0 + 4(2)2 + 7(1)(-1) - 7(2)2 - 3(2)(-1) - 4(1)0$$

$$= 0 + 16 - 7 - 28 + 6 - 0 = -13$$

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{47}{20} = 2.35\ A$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{16}{20} = 0.8\ A$$

$$I_3 = \frac{\Delta_3}{\Delta} = \frac{-13}{20} = -0.65\ A$$