

Augmented Matrix Solutions on the TI-89

The material shown below demonstrates how to use the TI-89 to use the augmented matrix method of solving linear systems and to put matrices in reduced row-echelon.

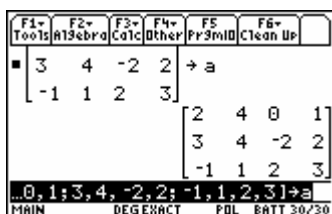
Example

Solve the given system of equations.

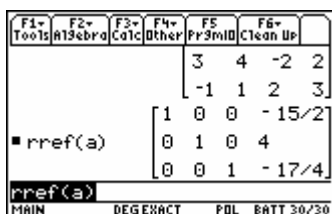
$$\begin{aligned} 2x + 4y &= 1 \\ 3x + 4y - 2z &= 2 \\ -x + y + 2z &= 3 \end{aligned}$$

Using Reduced row-echelon form (rref) to Solve Linear Systems

It is often easier to store the matrix you are working on in a memory location. This example stores the initial augmented matrix in memory location **a**. Notice that elements in a row are separated by commas and the next column is indicated by a semicolon, i.e. [2, 4, 0, 1; 3, 4, -2, 2; -1, 1, 2, 3]. The \rightarrow is entered by pressing the **STO** button (Row 8 Column 1) key.



Reduced row-echelon form (rref) can be obtained on the TI-89 in one step by using `rref(matrix)`. To enter `rref()`, press CATALOG button (Row 3 Column 3), followed by `s` (key 3) and then use the up arrow to select `rref()`. Press **ENTER** button to place `rref()` on the command line.



It follows that the answer is: $(x, y, z) = (-7.5, 4, -4.25)$.

This gives a convenient way quickly check to see if you can the correct answer.

Steps used to put a Matrix into Reduced Row Echelon Form

Step 1

- Make $R1C1 = 1$.
 - Rows are interchanged by `rowSwap(matrix, index1, index2)`. In this case we are interchanging rows 1 and 3. Notice that the result is stored into **a1**.

F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up
$\begin{bmatrix} 0 & 0 & 1 & -17/4 \\ -1 & 1 & 2 & 3 \\ 3 & 4 & -2 & 2 \\ 2 & 4 & 0 & 1 \end{bmatrix}$					
■ rowSwap(a, 1, 3) → a1					
$\begin{bmatrix} -1 & 1 & 2 & 3 \\ 0 & 0 & 1 & -17/4 \\ 3 & 4 & -2 & 2 \\ 2 & 4 & 0 & 1 \end{bmatrix}$					
■ rowSwap(a, 1, 3) → a1					
MAIN DEG EXACT PDL BATT 30/30					

- Rows are multiplied by a constant using `mRow(expression, matrix, index)`. In this case we want to multiply row 1 by -1. Notice that the `mRow` operation is applied to **a1** and the result is stored into **a2**.

F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up
$\begin{bmatrix} 2 & 4 & 0 & 1 \\ 1 & -1 & -2 & -3 \\ 3 & 4 & -2 & 2 \\ 2 & 4 & 0 & 1 \end{bmatrix}$					
■ mRow(-1, a1, 1) → a2					
$\begin{bmatrix} -1 & 1 & -2 & -3 \\ 2 & 4 & 0 & 1 \\ 3 & 4 & -2 & 2 \\ 2 & 4 & 0 & 1 \end{bmatrix}$					
■ mRow(-1, a1, 1) → a2					
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- Make zeros below $R1C1$.

Adding suitable multiples of the top row to rows below so that all entries below the leading 1 in column 1 become zero is accomplished by using `mRowAdd(expression, matrix, index1, index2)`. Notice that the first operation modifies **a2** and the result is stored into **a3**. The second operation modifies **a3** and is stored in **a4**.

F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up
$\begin{bmatrix} 2 & 4 & 0 & 1 \\ 1 & -1 & -2 & -3 \\ 0 & 7 & 4 & 11 \\ 2 & 4 & 0 & 1 \end{bmatrix}$					
■ mRowAdd(-3, a2, 1, 2) → a3					
$\begin{bmatrix} 2 & 4 & 0 & 1 \\ 0 & 7 & 4 & 11 \\ 0 & 7 & 4 & 11 \\ 2 & 4 & 0 & 1 \end{bmatrix}$					
■ mRowAdd(-3, a2, 1, 2) → a3					
MAIN DEG EXACT PDL BATT 30/30					

F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up
$\begin{bmatrix} 2 & 4 & 0 & 1 \\ 1 & -1 & -2 & -3 \\ 0 & 7 & 4 & 11 \\ 0 & 6 & 4 & 7 \end{bmatrix}$					
■ mRowAdd(-2, a3, 1, 3) → a4					
$\begin{bmatrix} 2 & 4 & 0 & 1 \\ 1 & -1 & -2 & -3 \\ 0 & 7 & 4 & 11 \\ 0 & 6 & 4 & 7 \end{bmatrix}$					
■ mRowAdd(-2, a3, 1, 3) → a4					
MAIN DEG EXACT PDL BATT 30/30					

Steps used to put a Matrix into Reduced Row Echelon Form (continued)

Step 2

- Make $R_{2C2} = 1$.

Rows are multiplied by a constant using `mRow(expression, matrix, index)`. In this case we want to multiply row 2 by $1/7$. The `mRow` operation modifies **a4** and the result is stored in **a5**.

F1	F2	F3	F4	F5	F6
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up
$\begin{bmatrix} 0 & 6 & 4 & 7 \\ 1 & -1 & -2 & -3 \\ 0 & 1 & 4/7 & 11/7 \\ 0 & 6 & 4 & 7 \end{bmatrix}$					
mRow(1/7, a4, 2) → a5					
$\begin{bmatrix} 0 & 6 & 4 & 7 \\ 1 & -1 & -2 & -3 \\ 0 & 1 & 4/7 & 11/7 \\ 0 & 6 & 4 & 7 \end{bmatrix}$					
mRow(1/7, a4, 2) → a5					
MAIN	DEGERACT	PDL	B:11	30/30	

- Make zeros above and below the leading 1 in row 2 and column 2.

F1	F2	F3	F4	F5	F6
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up
$\begin{bmatrix} 0 & 6 & 4 & 7 \\ 1 & 0 & -10/7 & -10/7 \\ 0 & 1 & 4/7 & 11/7 \\ 0 & 6 & 4 & 7 \end{bmatrix}$					
mRowAdd(1, a5, 2, 1) → a6					
$\begin{bmatrix} 0 & 6 & 4 & 7 \\ 1 & 0 & -10/7 & -10/7 \\ 0 & 1 & 4/7 & 11/7 \\ 0 & 6 & 4 & 7 \end{bmatrix}$					
mRowAdd(1, a5, 2, 1) → a6					
MAIN	DEGERACT	PDL	B:11	30/30	

F1	F2	F3	F4	F5	F6
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up
$\begin{bmatrix} 0 & 6 & 4 & 7 \\ 1 & 0 & -10/7 & -10/7 \\ 0 & 1 & 4/7 & 11/7 \\ 0 & 0 & 4/7 & -17/7 \end{bmatrix}$					
mRowAdd(-6, a6, 2, 3) → a7					
$\begin{bmatrix} 0 & 6 & 4 & 7 \\ 1 & 0 & -10/7 & -10/7 \\ 0 & 1 & 4/7 & 11/7 \\ 0 & 0 & 4/7 & -17/7 \end{bmatrix}$					
mRowAdd(-6, a6, 2, 3) → a7					
MAIN	DEGERACT	PDL	B:11	30/30	

Step 3

- Make $R_{3C3} = 1$

F1	F2	F3	F4	F5	F6
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up
$\begin{bmatrix} 0 & 0 & 4/7 & -17/7 \\ 1 & 0 & -10/7 & -10/7 \\ 0 & 1 & 4/7 & 11/7 \\ 0 & 0 & 1 & -17/4 \end{bmatrix}$					
mRow(7/4, a7, 3) → a8					
$\begin{bmatrix} 0 & 0 & 4/7 & -17/7 \\ 1 & 0 & -10/7 & -10/7 \\ 0 & 1 & 4/7 & 11/7 \\ 0 & 0 & 1 & -17/4 \end{bmatrix}$					
mRow(7/4, a7, 3) → a8					
MAIN	DEGERACT	PDL	B:11	30/30	

- Make zeros above the leading 1 in row 3 and column 3.

F1	F2	F3	F4	F5	F6
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up
$\begin{bmatrix} 0 & 0 & 1 & -17/4 \\ 1 & 0 & 0 & -15/2 \\ 0 & 1 & 4/7 & 11/7 \\ 0 & 0 & 1 & -17/4 \end{bmatrix}$					
mRowAdd(10/7, a8, 3, 1) → a9					
$\begin{bmatrix} 0 & 0 & 1 & -17/4 \\ 1 & 0 & 0 & -15/2 \\ 0 & 1 & 4/7 & 11/7 \\ 0 & 0 & 1 & -17/4 \end{bmatrix}$					
mRowAdd(10/7, a8, 3, 1) → a9					
MAIN	DEGERACT	PDL	B:11	30/30	

F1	F2	F3	F4	F5	F6
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up
$\begin{bmatrix} 0 & 0 & 1 & -17/4 \\ 1 & 0 & 0 & -15/2 \\ 0 & 1 & 0 & 4 \\ 0 & 0 & 1 & -17/4 \end{bmatrix}$					
mRowAdd(-4/7, a9, 3, 2) → a10					
$\begin{bmatrix} 0 & 0 & 1 & -17/4 \\ 1 & 0 & 0 & -15/2 \\ 0 & 1 & 0 & 4 \\ 0 & 0 & 1 & -17/4 \end{bmatrix}$					
mRowAdd(-4/7, a9, 3, 2) → a10					
MAIN	DEGERACT	PDL	B:11	30/30	