Basic Matrix Manipulation with a TI-89/TI-92/Voyage 200

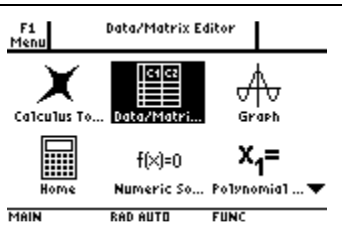
Often, a matrix may be too large or too complex to manipulate by hand. For these types of matrices, we can employ the help of graphing calculators to solve them.

Throughout the directions, words appearing in **bold** indicate calculator buttons. To learn more about your TI-89, TI-92, or Voyage 200, consult the manufacturer's product manual.

I will be using the TI-89 graphing calculator for these directions. The TI-92 and Voyage 200 are virtually the same, yet the menus may be slightly different due to their wider displays. I will be utilizing the Apps Desktop available in the latest firmware for these three calculators. If it is not turned on by default, press [MODE] and scroll all the way down to the last setting. Turn on the Apps Desktop and press [ENTER] to save the change.

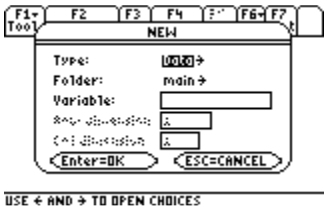
Inputting/Editing Matrices:

Before we can work with matrices, we must first input them into the calculator. To enter the Matrix Editor, scroll over to the "Data/Matrix Editor" icon on the Apps Desktop and press [ENTER].

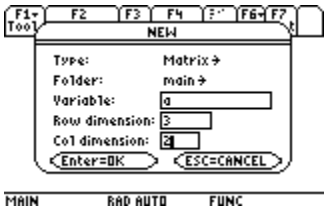


Since we want to enter a new matrix, scroll down to "New…" and press [ENTER].

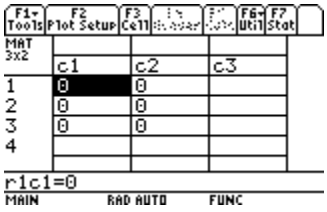
The Data/Matrix Editor allows us to input into the TI-89 more than just matrices. We can also enter lists and data (essentially a matrix without fixed dimensions).



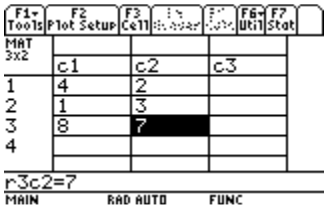
Let's say we want a 3x2 matrix. We first need to tell the Editor that we want to input a matrix. At the "Type" option, press the **RIGHT** arrow key, select "Matrix" and press [ENTER]. Press the **DOWN** arrow key twice to "Variable" and press [=] to type an "a". Press the **DOWN** arrow key to "Row dimension". Since, the calculator is still in alpha lock from the "Variable" box, press [alpha] once to exit that lock. Now press [3] → ⊙ → [2] to enter the matrix dimensions. Press [ENTER] once to confirm the column dimension, then again to create the matrix.



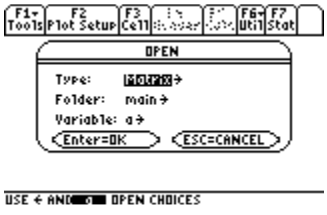
You should now have this screen. As you can see, we have a 3x2 matrix filled with zeros. To input your own matrix, type in each element of the matrix row-by-row. That is, to enter the matrix $\begin{bmatrix} 4 & 2 \\ 1 & 3 \\ 8 & 7 \end{bmatrix}$, type: [4] → [ENTER] → [2] → [ENTER] → [1] →[ENTER] → [3] → [ENTER] → [8] → [ENTER] → [7] → [ENTER].



And this is what you should have. Before we can use this matrix, we need to first exit the Data/Matrix Editor. To do this, do not press [CLEAR]! Pressing [CLEAR] will remove the selected number. Instead, press the [HOME] button to exit to the Home screen, or the [APPS] button to return to the Apps Desktop.



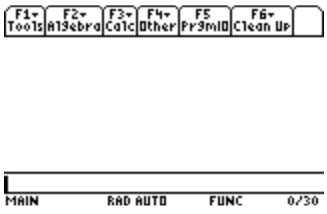
To edit the matrix, return to the Data/Matrix Editor, but this time select "Open". Change the type to "Matrix", make sure "a" is the selected variable, and press [ENTER]. The matrix "a" will now be displayed for editing. Remember to always press [HOME] or [APPS] to exit the Editor!



What if we need to change the matrix dimensions? After opening the matrix, press [2nd] → [F1] to display the "Utilities" menu and scroll down to "Resize Matrix"; press [ENTER]. Type in the new dimensions and press [ENTER] to apply them.

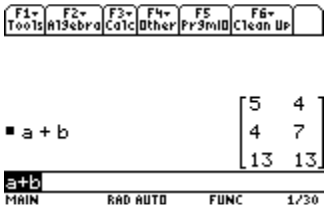
Adding and Subtracting Matrices:

Enter two matrices into the calculator as shown above, one as "a" and the other as "b". For this example, a = $\begin{bmatrix} 4 & 2 \\ 1 & 3 \\ 8 & 7 \end{bmatrix}$ and b = $\begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{bmatrix}$. Make sure you are at the Home screen while using matrices in computations.



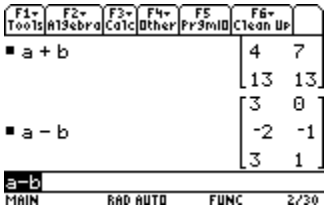
To add these two matrices together, do the following:
[alpha] → [=] (for "A") → [+] → [alpha] → [(] (for "B") → [ENTER]

If done correctly, you should see this screen.



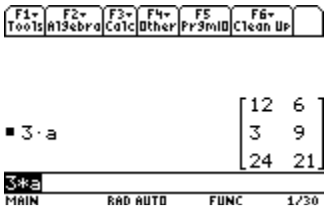
Subtracting matrices is similar, except type a subtraction sign instead of an addition sign.

(Remember, matrices must be the same dimension in order to add or subtract them. The calculator will return an error if the dimensions are not the same.)



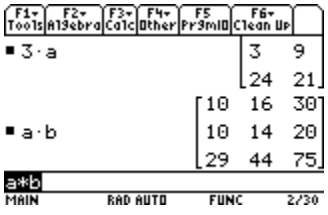
Multiplying Matrices:

Matrix multiplication is easy on the TI-89. For scalar multiplication, multiply the number times the matrix just like multiplying two numbers together. For example, to multiply 3 times the matrix "a", type: [3] → [×] → [alpha] → "A" → [ENTER].



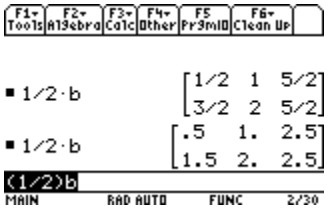
Multiplying two matrices together is just as easy. However, remember to have the correct matrix dimensions, otherwise the calculator will give a "Dimension" error. For this example, a = $\begin{bmatrix} 4 & 2 \\ 1 & 3 \\ 8 & 7 \end{bmatrix}$ and b = $\begin{bmatrix} 1 & 2 & 5 \\ 3 & 4 & 5 \end{bmatrix}$.

Try duplicating my screen by multiplying "a" and "b" together.



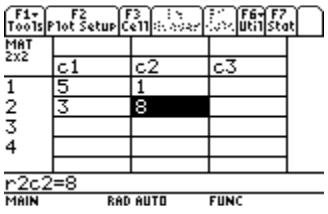
Notice that if the scalar is a fraction, the TI-89 will return fractions in the answer. If decimals are desired, press [♦] → [ENTER] after the initial multiplication.

Unlike some other TI graphing calculators with matrices, the TI-89 understands "b/2" to be the same as "(1/2)b".

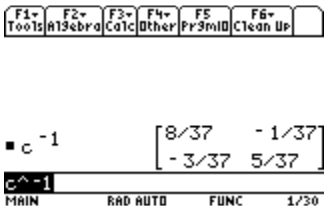


Calculating the Inverse:

To calculate a matrix inverse, first input $\begin{bmatrix} 5 & 1 \\ 3 & 8 \end{bmatrix}$ as matrix "c" into the TI-89. (Of course the matrix must be square, otherwise the calculator will return a "Dimension" error). Press [HOME] to exit to the Home screen.



Press [alpha] → "C" → [^] → [(-)] → [1] → [ENTER].

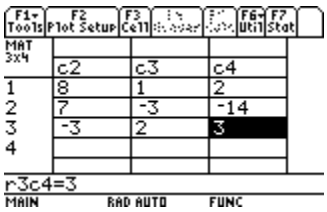


Gaussian and Gauss-Jordan Elimination:

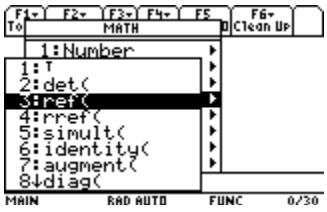
Let's use these two methods to solve the following system of equations:

$$\left.\begin{aligned} 4x+8y+z&=2\\ x+7y-3z&=-14\\ 2x-3y+2z&=3 \end{aligned}\right\} \rightarrow \begin{bmatrix} 4 & 8 & 1 & 2\\ 1 & 7 & -3 & -14\\ 2 & -3 & 2 & 3 \end{bmatrix}$$

Input the augmented matrix as matrix "a".

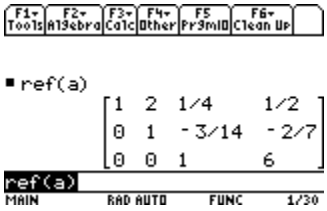


Press HOME to exit the Editor. Let's first try solving the system using the Gaussian Elimination method. Press 2nd → 5 to enter the calculator's Math menu. Scroll down to "Matrix", press the **RIGHT** arrow key, and select the "ref(" command ("Row-Echelon Form"). Press ENTER to paste the command to the Home screen.



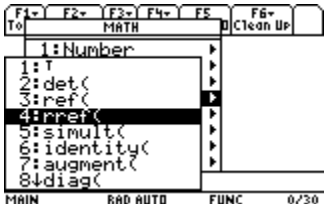
Type alpha → "A" →) → ENTER to run the command on matrix "a". If a "▶" appears in the answer, this means that the matrix extends beyond the calculator's screen; select the answer and use the **LEFT** and **RIGHT** arrow keys to scroll the matrix.

Note that if you swap rows, the matrix given by the "ref(" command may not match the matrix obtained by performing the Gaussian elimination by hand. That is fine; the final solution will be the same.

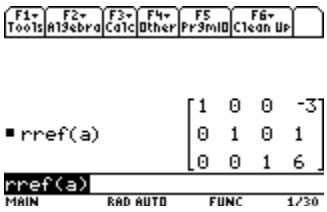


Now let's try the Gauss-Jordan elimination method. If you have calculated this method by hand, then you know that the answer will be obtained at the end. The same applies to the TI-89.

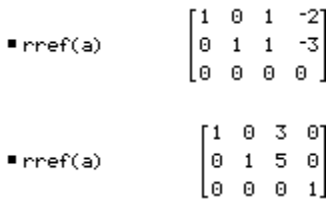
Press 2nd → 5 to return to the Math menu, but this time scroll down to the "rref(" command ("Reduced Row-Echelon Form"), directly below "ref(". Press ENTER to paste the command to the Home screen.



Type alpha → "A" →) → ENTER to run the command on matrix "a". There we go! The solution to our system of equations is (-3, 1, 6).



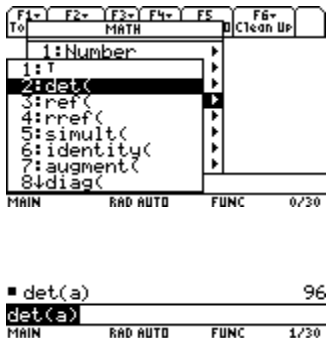
Now what if we have a dependent or inconsistent system? The "rref(" command will still work on the augmented matrices of these systems, but with different results than above. For a dependent system, a matrix with the last row all zeros would be returned (first picture on the right). For an inconsistent system, a matrix would be returned where the last row contains all zeros except for a final element of "1" (second picture on the right).



Determinants:

Input this matrix as matrix "a" in the calculator: $\begin{bmatrix} 4 & 2 & 1 \\ 5 & 7 & 2 \\ 1 & -3 & 5 \end{bmatrix}$

To calculate the determinant of "a", press 2nd → 5 to enter the calculator's Math menu, scroll down to "Matrix", press the **RIGHT** arrow key and select the "det(" command. Press ENTER to paste the command to the Home screen. Type alpha → "A" →) → ENTER to run the command on matrix "a". That's it! The determinant of this matrix is 96.



Transpose:

Let's calculate the transpose of $\begin{bmatrix} 4 & 2 & 1 \\ 5 & 7 & 2 \\ 1 & -3 & 5 \end{bmatrix}$. If it is not there already, input this matrix as "a" in the calculator. Press alpha → "A" to type "a" on the Home screen, then go back to the Math menu, enter the "Matrix" submenu and select the first command. Press ENTER to paste the command to the screen, and then ENTER again to run the command.

Deleting Matrices from the Calculator:

Deleting matrices from the TI-89 is not too hard, but we must be careful. We will be entering an area of the calculator where we could possibly delete something that we did not intend to. First, press [2nd] → **VAR-LINK** (above the [−] key). Use the **UP** and **DOWN** arrow keys to select the matrix you want to delete, and then press the [←] key. Press [ENTER] to confirm or [ESC] to cancel. Make sure to press [HOME] to return to the Home screen.