Matrices and the TI-83, TI-83+, and the TI-84

The TI-83 has a matrix key, labeled MATRX. The matrix capability on the TI-83+ and the TI-84 will be found above the x^2 key, and will be labeled MATRX or MATRIX. For simplicity, the word MATRIX is used throughout this document.

1. Entering a matrix such as

\[
\begin{bmatrix}
1 & -2 & 3 & 9 \\
-1 & 3 & 0 & -4 \\
2 & -5 & 5 & 17
\end{bmatrix}
\]

- **MATRIX → EDIT**
- Choose 1:[A].
- Choose the size of the matrix by entering the values where the cursor is blinking. Use 3x4 for our matrix.
- Now enter each element of the matrix. Press ENTER after each entry. The cursor moves to the right after each entry.
- When the matrix is entered, go back to the Home Screen with 2nd QUIT.
- To view the matrix in the Home Screen: **MATRIX → NAMES → [A] → ENTER**.

Note: Whenever we want a matrix name, such as [A], to appear in the home screen, we access the name with this process: **MATRIX → NAMES → [A] → ENTER**. We cannot just type in the A.

2. Matrix addition
- To add [A] + [B], the Home Screen will need to look like this: **[A] + [B]**.
- Enter each matrix and then access the matrix names as indicated in the box above.
- To practice adding matrices, let’s find [A] + [B], if

\[
\begin{bmatrix}
4 & 3 \\
2 & 1
\end{bmatrix}
\]

and

\[
\begin{bmatrix}
8 & 7 \\
6 & 5
\end{bmatrix}
\]

The result should be

\[
\begin{bmatrix}
12 & 10 \\
8 & 6
\end{bmatrix}
\]

3. Scalar multiplication
- To multiply a matrix [A] by a number, such as 3, your Home Screen should look like this: **3*[A]**.
- To practice scalar multiplication, find 3*[A], if [A] = \[
\begin{bmatrix}
1 & 2 \\
3 & 4
\end{bmatrix}
\]

The result of the scalar multiplication, 3*[A], should be:

\[
\begin{bmatrix}
3 & 6 \\
9 & 12
\end{bmatrix}
\]

4. Matrix multiplication
- To multiply 2 matrices together, such as [A] and [B], the Home Screen should look like this: **[A]*[B]**

Note that the number of columns in the 1st matrix must equal the number of rows in the 2nd matrix.

- To practice matrix multiplication, find [A]*[B], if [A] = \[
\begin{bmatrix}
1 & 2 & 3 \\
4 & 5 & 6
\end{bmatrix}
\]

and [B] = \[
\begin{bmatrix}
7 & 8 & 9 & 10 \\
11 & 12 & 13 & 14 \\
15 & 16 & 17 & 18
\end{bmatrix}
\]

Note that [A] is 2 x 3, and [B] is 3 x 4. Since there are 3 columns in [A] and 3 rows in [B], it is possible to multiply [A] x [B].

The result of the matrix multiplication, [A]*[B] will be the 2 x 4 matrix:

\[
\begin{bmatrix}
74 & 80 & 86 & 92 \\
173 & 188 & 203 & 218
\end{bmatrix}
\]
5. Determinant of a matrix

- The det can be found in \( \text{MATRIX} \rightarrow \text{MATH} \). The first choice is \( \text{det} \).
- The Home Screen should look like this: \( \text{det} [A] \)
  
  Note that a determinant can be found for a square matrix only.

- To practice, find the determinant of \( [A] \), if 
  
  \[
  [A] = \begin{bmatrix}
  -1 & 3 & 0 \\
  2 & -5 & 5 \\
  \end{bmatrix}
  \]

- The result of \( |A| \), the determinant of \( [A] \), is 2.

6. Inverse of a matrix

- To find the inverse of a matrix \( A \), the Home Screen should look like this: \( [A]^{-1} \)
  
  Note that the exponent, \( -1 \), is accessed by pressing the \( x^{-1} \) key on the calculator.

- To practice, find the inverse of matrix \( A \), if 
  
  \[
  [A] = \begin{bmatrix}
  1 & -2 & 3 \\
  -1 & 3 & 0 \\
  2 & -5 & 5 \\
  \end{bmatrix}
  \]

  The result should be 
  
  \[
  \begin{bmatrix}
  7.5 & -2.5 & -4.5 \\
  2.5 & -5 & -1.5 \\
  -5 & 5 & .5 \\
  \end{bmatrix}
  \]

- To change the entries of the resulting matrix to fractions: \( \text{MATH} \rightarrow \text{Frac} \rightarrow \text{Enter} \).

  If the entries are changed to fractions, the result should be 
  
  \[
  \begin{bmatrix}
  15/2 & -5/2 & -9/2 \\
  5/2 & -1/3 & -3/2 \\
  -1 & 1/2 & 1/2 \\
  \end{bmatrix}
  \]

7. Using the inverse matrix to solve a system

- To solve the system 
  
  \[
  \begin{align*}
  2x - 5y + 5z &= 17 \\
  -x + 3y &= -4 \\
  x - 2y + 3z &= 9 \\
  \end{align*}
  \]

  with the inverse matrix method, 

  enter \( [A] = \begin{bmatrix}
  2 & -5 & 5 \\
  -1 & 3 & 0 \\
  1 & -2 & 3 \\
  \end{bmatrix} \)

  and \( [B] = \begin{bmatrix}
  17 \\
  -4 \\
  9 \\
  \end{bmatrix} \)

- The Home Screen should look like this: \( [A]^{-1} \cdot [B] \)

- The result is \( \begin{bmatrix}
  1 \\
  -1 \\
  2 \\
  \end{bmatrix} \) which means that (1, -1, 2) is the solution to the system.
8. ref and rref are found in \textbf{MATRIX}→\textbf{MATH}.
To solve a system of equations we can find the reduced row echelon form of a matrix.
The Home Screen should look like this: \textbf{rref}([A])
- Find \textbf{rref} in \textbf{MATRIX} \rightarrow \textbf{MATH}. Arrow down to \textbf{rref}.
- To practice finding the reduced row echelon form, find \textbf{rref}([A]), if \([A] = \begin{bmatrix} -1 & 3 & 0 & -4 \\ 1 & -2 & 3 & 9 \\ 2 & -5 & 5 & 17 \end{bmatrix}\)
- The result of the \textbf{rref}([A]) should be: \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 1 & 2 \end{bmatrix}. So, (1, -1, 2) is the solution.

9. \textbf{Elementary row operations} are found in \textbf{MATRIX}→\textbf{MATH}.
After applying each of the row operations below, store the matrix at the original matrix name, by using the \textbf{STO} \rightarrow key at the bottom of the keys on the left of the keyboard.

- \textbf{rowSwap} is used to swap rows. The template is: \textbf{rowSwap}([matrix name], a row number, the other row number) \rightarrow [matrix name]
- \textbf{row+} is used to add one row to another and store the result in the other row. The template is: \textbf{row+}([matrix name], a row number, the other row number) \rightarrow [matrix name]
- \textbf{*row} is used to multiply a row by a constant and store the result in the same row. The template is: \textbf{*row}(constant multiplier,[matrix name], row number) \rightarrow [matrix name]
- \textbf{*row+} is used to multiply a row by a constant, add the new values to another row, and store the result in the other row. The template is: \textbf{*row+}(constant multiplier,[matrix name],a row number, the other row number) \rightarrow [matrix name]

We’ll start with matrix [A] above:
\[
\begin{bmatrix}
-1 & 3 & 0 & -4 \\
1 & -2 & 3 & 9 \\
2 & -5 & 5 & 17
\end{bmatrix}
\]

- Let’s get a 1 in the upper left position:
We’ll swap row 1 and row 2 of our matrix [A] and store as a new [A]: \textbf{rowSwap}([A],1,2)\rightarrow [A]
The result should be:
\[
\begin{bmatrix}
1 & -2 & 3 & 9 \\
-1 & 3 & 0 & -4 \\
2 & -5 & 5 & 17
\end{bmatrix}
\]
• Let’s get a 0 in the first position of the 2nd row: We’ll add row 1 to row 2 and store in row 2, and then store as a new [A]: \[ \text{row}+([A],1,2) \rightarrow [A] \]

\[
\begin{bmatrix}
1 & -2 & 3 & 9 \\
0 & 1 & 3 & 5 \\
2 & -5 & 5 & 17
\end{bmatrix}
\]
The result should be:

\[
\begin{bmatrix}
1 & -2 & 3 & 9 \\
0 & 1 & 3 & 5 \\
2 & -5 & 5 & 17
\end{bmatrix}
\]

• Let’s get a 0 in the first position of the 3rd row: Multiply -2 times row 1 and add the result into row 3, storing in row 3: \[ *\text{row}(-2,[A],1,3) \rightarrow [A] \]

\[
\begin{bmatrix}
1 & -2 & 3 & 9 \\
0 & 1 & 3 & 5 \\
0 & -1 & -1 & -1
\end{bmatrix}
\]
The result should be:

\[
\begin{bmatrix}
1 & -2 & 3 & 9 \\
0 & 1 & 3 & 5 \\
0 & -1 & -1 & -1
\end{bmatrix}
\]

• Let’s get a 0 in the 2nd position of the 3rd row: \[ \text{row}([A],2,3) \rightarrow [A] \]

\[
\begin{bmatrix}
1 & -2 & 3 & 9 \\
0 & 1 & 3 & 5 \\
0 & 0 & 2 & 4
\end{bmatrix}
\]
The result should be:

\[
\begin{bmatrix}
1 & -2 & 3 & 9 \\
0 & 1 & 3 & 5 \\
0 & 0 & 2 & 4
\end{bmatrix}
\]

• Let’s get a 1 in the 3rd position of the 3rd row: \[ *\text{row}(1/2,[A],3) \rightarrow [A] \]

\[
\begin{bmatrix}
1 & -2 & 3 & 9 \\
0 & 1 & 3 & 5 \\
0 & 0 & 1 & 2
\end{bmatrix}
\]
The result should be:

\[
\begin{bmatrix}
1 & -2 & 3 & 9 \\
0 & 1 & 3 & 5 \\
0 & 0 & 1 & 2
\end{bmatrix}
\]

The final matrix gives the resulting equations:

\[
x - 2y + 3z = 9 \\
y + 3z = 5 \\
z = 2
\]

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