Matrices and the TI-86

The TI-86 matrix capability is located at MATRX, above the 7 key.

1. Entering a matrix such as $\begin{bmatrix} 1 & -2 & 3 & 9 \\ -1 & 3 & 0 & -4 \\ 2 & -5 & 5 & 17 \end{bmatrix}$

- **MATRX → EDIT**
- Type in a matrix name such as A, located above LOG.
- ENTER
- 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** or the **EXIT** key.
- To view the matrix in the Home Screen, type the letter A with ALPHA and then A.

2. Matrix addition

- To add 2 matrices, such as A +[B, enter each matrix first.
- Then make the Home Screen look like: **A + B**.
- To practice adding matrices, let's enter matrix A = $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ and matrix B = $\begin{bmatrix} 5 & 6 \\ 7 & 8 \end{bmatrix}$.

  The result should be $\begin{bmatrix} 6 & 8 \\ 10 & 12 \end{bmatrix}$.

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, use matrix 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

- Enter a matrix A and matrix B, but be sure that the number of *columns* in the 1st matrix is equal to the number of *rows* in the 2nd matrix.
- To practice matrix multiplication, find **A*B**, if matrix A = $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$ and matrix 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 will be the 2 x 4 matrix: $\begin{bmatrix} 74 & 80 & 86 & 92 \\ 173 & 188 & 203 & 218 \end{bmatrix}$

  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.

5. Determinant of a matrix

- The **det** can be found in **MATRX** $\rightarrow$ **MATH**. The first choice is **det**.
- The Home Screen should look like this: **det A**
  Note that a determinant can be found for a square matrix only.
- To practice, find the determinant of matrix A , if matrix A = $\begin{bmatrix} 1 & -2 & 3 \\ -1 & 3 & 0 \\ 2 & -5 & 5 \end{bmatrix}$.
- The result of |A|, the determinant of matrix A, is 2.

6. Inverse of a matrix

- To find the inverse of a matrix A, the Home Screen should look like this: $\mathbf{A^{-1}}$
  Note that a matrix must be square to have an inverse.
  Note that the exponent, -1, is located above the EE key.
- To practice, find the inverse of matrix A, if matrix 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: **MATH** $\rightarrow$ **►FRAC** $\rightarrow$ **ENTER**.

  The **►FRAC** is most easily found in the CATALOG, above the "a" words.
- If the entries are changed to fractions, the result should be $\begin{bmatrix} \frac{15}{2} & -\frac{5}{2} & -\frac{9}{2} \\ \frac{5}{2} & -\frac{1}{2} & -\frac{3}{2} \\ -\frac{1}{2} & \frac{1}{2} & \frac{1}{2} \end{bmatrix}$.

7. Using the inverse matrix to solve a system

- To solve the system

$$\begin{aligned} 2x - 5y + 5z &= 17 \\ -x + 3y &= -4 \\ x - 2y + 3z &= 9 \end{aligned}$$

with the inverse matrix method,

enter matrix A = $\begin{bmatrix} 2 & -5 & 5 \\ -1 & 3 & 0 \\ 1 & -2 & 3 \end{bmatrix}$ and matrix B = $\begin{bmatrix} 17 \\ -4 \\ 9 \end{bmatrix}$.

- The Home Screen should look like this: $\mathbf{A^{-1} * B}$
- 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 **MATRX → OPS**.

To solve a system of equations we can find the reduced row echelon form of a matrix.
The Home Screen should look like this: **rref A**

- To practice finding the reduced row echelon form, find rref A, if [A] = $\begin{bmatrix} -1 & 3 & 0 & -4 \\ 1 & -2 & 3 & 9 \\ 2 & -5 & 5 & 17 \end{bmatrix}$
- The result of the 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. **Elementary row operations** are found in **MATRX → OPS**.

After applying each of the row operations below, store the new matrix at the original matrix name, each time, by using the **STO►** key at the bottom of the keys on the left of the keyboard.

rSwap is used to swap two rows.
The template is: **rSwap(matrix name, a row number, the other row number) → matrix name**

rAdd is used to add one row to another and store the result in the other row**.**
The template is: **rAdd(matrix name, a row number, the other row number) → matrix name**

multR is used to multiply a row by a constant and store the result in the same row.
The template is: **multR(constant multiplier,matrix name, row number) → matrix name**

mRAdd is used to multiply a row by a constant, add it to another row, and store the result in the second row. The template is:
mRAdd(constant multiplier,matrix name, a row number, the other row number) → 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: **rSwap(A,1,2)→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. The Home Screen should look like: **rAdd(A,1,2) →A**
  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: **mRAdd (-2,A,1,3)→A**

  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: **rAdd(A,2,3) →A**

  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: **multR(1/2,A,3)→A**

  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:

$$\begin{aligned} x \quad - 2y \quad + 3z &= 9 \\ y \quad + 3z &= 5 \\ z &= 2 \end{aligned}$$