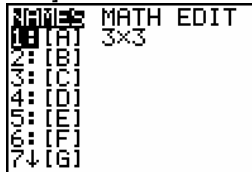**Matrix Operations on the TI-83**

For the examples, we will consider the matrix

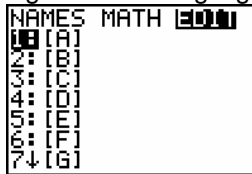$$\begin{array}{rrrr} 2 & 7 & 6 & -7 \\ -3 & -5 & -7 & -2 \\ -2 & 3 & 8 & 5 \end{array}$$

**A. How to type in a matrix into the TI-83**

Hit [MATRX]. You will see

```
NAMES MATH EDIT
1:[A]  3×3
2:[B]
3:[C]
4:[D]
5:[E]
6:[F]
7↓[G]
```

Use the right arrow to highlight "EDIT". You will see

```
NAMES MATH EDIT
1:[A]
2:[B]
3:[C]
4:[D]
5:[E]
6:[F]
7↓[G]
```

The [A], [B], [C], … are all "variables" into which you can store different matrices. If you want to put the matrix into [A], highlight "[A]" and hit [ENTER]; if you want to put the matrix into [B], use the down arrow to highlight "[B]" and hit [ENTER]; etc. For this example, we will put the matrix into [A], so hit [ENTER]. You will see

```
MATRIX[A] 1 ×1
[ 0            ]
```
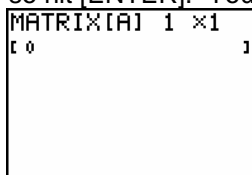
The first thing you need to do is set the order of the matrix (i.e. the number of rows and number of columns). The default setting, as you can see, is 1x1 (one row by one column). The matrix we want is 3 x 4 so we replace the first "1" by hitting [3], then the right-arrow, then replace the second "1" by hitting [4], then hit [ENTER]. You will see

```
MATRIX[A] 3 ×4
[ 0     0     0     _
[ 0     0     0     
[ 0     0     0     _

1,1=0
```
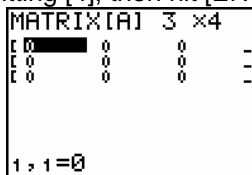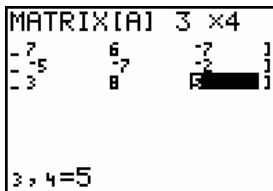
Observe that there is now a matrix of zeros. This matrix has 3 rows and 4 columns as desired.
Note: You can't see all the matrix here; some of the matrix is hidden off the screen to the right.

Now type in the numbers one-by-one by using the arrow keys to highlight the appropriate box and then typing the numbers in (the [ENTER] key moves you one box to the right). After typing in the sample matrix, you should see (depending on whether you are looking at the left-half or the right-half of the matrix)

```
MATRIX[A] 3 ×4          MATRIX[A] 3 ×4
[ 2     7     6     _    _ 7     6     -7    ]
[ -3    -5    -7    _    _ -5    -7    -2    ]
[ -2    3     8     _    _ 3     8     5     ]



3,1=-2            or    3,4=5
```

Now the matrix is typed in and stored in the "variable" [A}. Hit [2ⁿᵈ] [QUIT] to exit the matrix menu.

B. Row-Echelon Form

Once you type in a matrix and store it in a variable, whenever you want to do anything with that matrix you call it up as follows:

1: Hit [MATRX] and make sure "NAMES" is highlighted. You will see something like this:

```
NAMES MATH EDIT
1█[A]  3x4
2:[B]
3:[C]
4:[D]
5:[E]
6:[F]
7↓[G]
```

Then use the up and down arrows to choose the matrix you want and press [ENTER].

2: As an example, we will start by just displaying the matrix A. Quit any menu you are in by hitting [2nd] [QUIT], then hit [MATRX], make sure "NAMES" is highlighted, pick # 1, "[A]", and hit [ENTER]. You will see

```
[A]
```

3: Hit [ENTER]. The matrix pops up:

```
[A]
[[2   7   6   -7]
 [-3  -5  -7  -2]
 [-2  3   8   5 ]]
```

4: Now we can put the matrix A into row-echelon form. Hit [MATRX] and use the right arrow to highlight [MATH]. You will see

```
NAMES MATH EDIT
1█det(
2: T
3:dim(
4:Fill(
5:identity(
6:randM(
7↓augment(
```

5: Use the down arrow to highlight "A: ref(" as shown below, then hit [ENTER]:

```
NAMES MATH EDIT
7↑augment(
8:Matr▶list(
9:List▶matr(
0:cumSum(
A█ref(
B:rref(
C↓rowSwap(
```

6: After hitting [ENTER], you will see "ref(" on the screen. Now you call up the matrix you want to put into row-echelon form using [MATRX], "NAMES", "[A]", [ENTER] as above. You will see

```
ref([A]
```

7: Hit [ENTER]. The row-echelon form of the matrix pops up:

```
ref([A]
[[1  1.666666667…
 [0  1            …
 [0  0            …
■
```

8: To get rid of the repeating decimals, hit [MATH], choose ▶ Frac and hit [ENTER] twice. The decimals will be turned into fractions as follows:

```
[[1  1.666666667…
 [0  1            …
 [0  0            …
Ans▶Frac
[[1  5/3  7/3  2/3…
 [0  1    2    1  …
 [0  0    1    2  …
■
```

To see the rest of the matrix, hit the right arrow key to see the rest of the numbers:

```
[[1  1.666666667…
 [0  1            …
 [0  0            …
Ans▶Frac
…1  5/3  7/3  2/3]
…0  1    2    1  ]
…0  0    1    2  ]]
```

You can see that a row-echelon form of our matrix is

1	5/3	7/3	2/3
0	1	2	1
0	0	1	2

C. Reduced Row-Echelon Form and Solving Systems of Equations

Even better, we can put a matrix into a form called the "reduced row-echelon form". To do that, repeat the steps to put the matrix into row-echelon form but instead of choosing "A: ref(" from the [MATRX] "MATH" menu, choose "B: rref(". Here is the command line and output for these steps:

```
rref([A]
      [[1 0 0 1 ]
       [0 1 0 -3]
       [0 0 1 2 ]]
■
```

This is the "reduced row-echelon form" for A. This is very useful to solve equations. For instance, consider the system of equations

$$2x + 7y + 6z = -7$$
$$-3x - 5y - 7z = -2$$
$$-2x + 3y + 8z = 5$$

This system gives the augmented matrix A that we used in our examples. To solve the system, we could put the matrix in row-echelon form and solve using back-substitution, or better, put the matrix into reduced row-echelon form, because then the solution for x,y, and z is obvious. For instance, the reduced row-echelon form of our example is

```
1   0   0   1
0   1   0   -3
0   0   1   2
```

which gives the solution to the system of equations

$$x = 1$$
$$y = -3$$
$$z = 2$$

Note: performing the "rref" operation on your calculator for a matrix will sometimes give you a matrix with a row of zeros or a row that looks like 0   0   0   -1 . Matrices like these correspond to an infinite number of solutions or no solution, respectively.