

## ROW OPERATIONS HOMEWORK

### The Three Row Operations

1. Interchange two rows.
2. Multiply a row by a nonzero constant.
3. Add a multiple of one row to another.

### Examples:

$$1. \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{R_1 \leftrightarrow R_2} \begin{pmatrix} 4 & 5 & 6 \\ 1 & 2 & 3 \\ 7 & 8 & 9 \end{pmatrix}.$$

$$2. \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{2R_1 \rightarrow R_1} \begin{pmatrix} 2 & 4 & 6 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}.$$

$$3. \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{-R_2 \rightarrow R_2} \begin{pmatrix} 1 & 2 & 3 \\ -4 & -5 & -6 \\ 7 & 8 & 9 \end{pmatrix}.$$

$$4. \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{2R_1 + R_3 \rightarrow R_3} \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 9 & 12 & 15 \end{pmatrix}$$

$$5. \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{-4R_1 + R_2 \rightarrow R_2} \begin{pmatrix} 1 & 2 & 3 \\ 0 & -3 & -6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{-7R_1 + R_3 \rightarrow R_3} \begin{pmatrix} 1 & 2 & 3 \\ 0 & -3 & -6 \\ 0 & -6 & -12 \end{pmatrix}.$$

$$\xrightarrow{\frac{-1}{3}R_2 \rightarrow R_2} \begin{pmatrix} 1 & 2 & 3 \\ 0 & 1 & 2 \\ 0 & -6 & -12 \end{pmatrix} \xrightarrow{6R_2 + R_3 \rightarrow R_3} \begin{pmatrix} 1 & 2 & 3 \\ 0 & 1 & 2 \\ 0 & 0 & 0 \end{pmatrix} \xrightarrow{-2R_2 + R_1 \rightarrow R_1} \begin{pmatrix} 1 & 0 & -1 \\ 0 & 1 & 2 \\ 0 & 0 & 0 \end{pmatrix}.$$

Exercises:

Let  $A = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix}$ .

1.  $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{R_1 \leftrightarrow R_3} ?$

2.  $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{R_2 \leftrightarrow R_3} ?$

3.  $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{3R_2 \rightarrow R_2} ?$

4.  $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{-2R_3 \rightarrow R_3} ?$

5.  $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{3R_3 + R_1 \rightarrow R_1} ?$

6.  $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{-R_1 + R_3 \rightarrow R_3} ?$

7.  $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{-6R_1 + R_3 \rightarrow R_3} ?$

8.  $\begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \xrightarrow{\frac{-3}{4}R_2 + R_3 \rightarrow R_3} ?$

9. Write the system of equations given below as an augmented matrix, apply the given row operations one at a time to transform the matrix into row echelon form, and then use back substitution to finish solving the system.

$$x + y + z = 6$$

$$x - y + z = 2$$

$$-x + y + z = 4$$

$$R_1 + R_3 \rightarrow R_3$$

$$-R_1 + R_2 \rightarrow R_2$$

$$R_2 + R_3 \rightarrow R_3$$

$$-\frac{1}{2}R_2 \rightarrow R_2$$

$$\frac{1}{2}R_3 \rightarrow R_3$$