# Assignment 2

## Mirha Sidheek

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## 1 QUESTION NO. 1.23 - LINEAR FORMS

Find the equation of the line, which makes intercepts $-3$ and $2$ on the $x$ and $y$ axes respectively.

## 2 SOLUTION

$$Given, x-intercept = -3, y-intercept = 2 \quad (2.0.1)$$

Hence , the line cuts through the x-axis at $\begin{pmatrix} -3 \\ 0 \end{pmatrix}$ and the line cuts through the y-axis at $\begin{pmatrix} 0 \\ 2 \end{pmatrix}$

$$\mathbf{A} = \begin{pmatrix} -3 \\ 0 \end{pmatrix}, \mathbf{B} = \begin{pmatrix} 0 \\ 2 \end{pmatrix} \quad (2.0.2)$$

Let the line equation be,

$$\mathbf{n^T x} = 1 \quad (2.0.3)$$

Then,

$$\mathbf{n^T A} = 1 \implies \mathbf{A^T n} = 1 \quad (2.0.4)$$

$$\mathbf{n^T B} = 1 \implies \mathbf{B^T n} = 1 \quad (2.0.5)$$

$$\mathbf{A^T} = \begin{pmatrix} -3 & 0 \end{pmatrix}, \mathbf{B^T} = \begin{pmatrix} 0 & 2 \end{pmatrix} \quad (2.0.6)$$

We find n by augmenting the matrix below and doing row reduction on it.

$$\begin{pmatrix} \mathbf{A^T} \\ \mathbf{B^T} \end{pmatrix} n = \begin{pmatrix} 1 \\ 1 \end{pmatrix} \quad (2.0.7)$$

Substituting values in 2.0.7 ,

$$\begin{pmatrix} -3 & 0 \\ 0 & 2 \end{pmatrix} n = \begin{pmatrix} 1 \\ 1 \end{pmatrix} \quad (2.0.8)$$

This can be row reduced as follows

$$\begin{pmatrix} -3 & 0 & 1 \\ 0 & 2 & 1 \end{pmatrix} \xleftarrow[R_1 \leftarrow R_1/-3]{R_2 \leftarrow R_2/2} = \begin{pmatrix} 1 & 0 & \frac{-1}{3} \\ 0 & 1 & \frac{1}{2} \end{pmatrix} \quad (2.0.9)$$

The left part is converted into identity matrix and the normal vector(n) is $\begin{pmatrix} \frac{-1}{3} \\ \frac{1}{2} \end{pmatrix}$ ie,

$$\mathbf{n} = \begin{pmatrix} \frac{-1}{3} \\ \frac{1}{2} \end{pmatrix} \quad (2.0.10)$$

$$\mathbf{n^T} = \begin{pmatrix} \frac{-1}{3} & \frac{1}{2} \end{pmatrix} \quad (2.0.11)$$

The equation of the line is found out by,

$$\mathbf{n^T x} = \mathbf{n^T A} \quad (2.0.12)$$

$$\begin{pmatrix} \frac{-1}{3} & \frac{1}{2} \end{pmatrix} x = \begin{pmatrix} \frac{-1}{3} & \frac{1}{2} \end{pmatrix} \begin{pmatrix} -3 \\ 0 \end{pmatrix} \quad (2.0.13)$$

$$= \begin{pmatrix} \frac{-1}{3} & \frac{1}{2} \end{pmatrix} x = 1 \quad (2.0.14)$$

Therefore, the equation of line is,

$$\begin{pmatrix} \frac{-1}{3} & \frac{1}{2} \end{pmatrix} x = 1 \quad (2.0.15)$$

Since the line passes through the points $\begin{pmatrix} -3 \\ 0 \end{pmatrix}$ and $\begin{pmatrix} 0 \\ 2 \end{pmatrix}$, The line AB is plotted using these points as shown below.
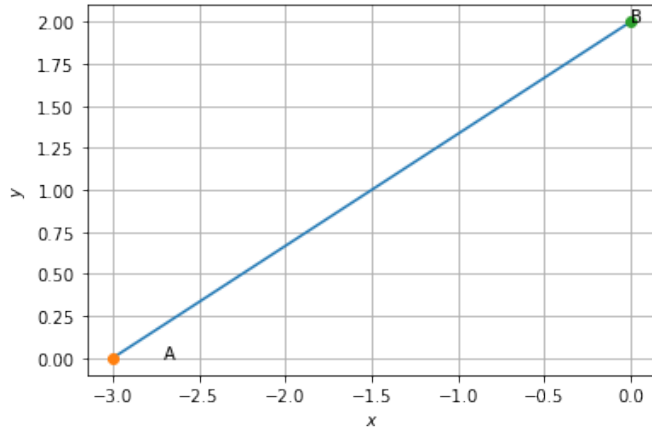


Fig. 0: The line $\begin{pmatrix} 2 & -3 \end{pmatrix} x = -6$