

# 4.3.13

EE25BTECH11026-Harsha

## Question:

Equations of the diagonals of the square formed by the lines  $x = 0$ ,  $y = 0$ ,  $x = 1$  and  $y = 1$  are \_\_\_\_\_.

## Solution:

Let us solve the given equation theoretically and then verify the solution computationally.

According to the question,

The vertices of the square are ,

$$\mathbf{a} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \quad \mathbf{b} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \quad \mathbf{c} = \begin{pmatrix} 1 \\ 1 \end{pmatrix} \quad \mathbf{d} = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$$

To compute the equation of the diagonals , we can use the normal form of the equation, which is given by

$$\mathbf{n}^T \mathbf{x} = 0 \text{ for the lines passing through the origin}$$

$$\mathbf{n}^T \mathbf{x} = 1 \text{ for the lines not passing through the origin}$$

where,

$\mathbf{n}$ -vector orthogonal to the direction vector

$$\mathbf{x} = \begin{pmatrix} x & y \end{pmatrix}^T$$

For diagonal  $\mathbf{c} - \mathbf{a}$ , as it passes through the origin,

$$\therefore \mathbf{n}^T \mathbf{x} = 0$$

By substituting the vector through which it passes through,

$$\mathbf{n}^T \begin{pmatrix} 1 \\ 1 \end{pmatrix} = 0$$

we get

$$\mathbf{n} = \begin{pmatrix} -1 \\ 1 \end{pmatrix}$$

$$\therefore \text{The equation of line is } \begin{pmatrix} -1 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = 0$$

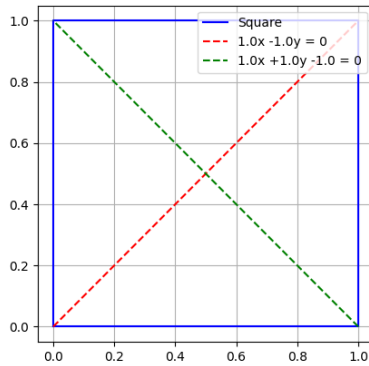
But, for diagonal  $\mathbf{d} - \mathbf{b}$ , as the diagonal doesn't pass through the origin,

$$\mathbf{n}^T \mathbf{x} = 1$$

As we know that the diagonal  $\mathbf{d} - \mathbf{b}$  pass through the vectors  $\begin{pmatrix} 1 & 0 \end{pmatrix}^T$  and  $\begin{pmatrix} 0 & 1 \end{pmatrix}^T$ , we can say that  $\mathbf{n}$  would be  $\begin{pmatrix} 1 & 1 \end{pmatrix}^T$

$$\therefore \text{The equation of line is } \begin{pmatrix} 1 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix} = 1$$

From the figure, it is clearly verified that the theoretical solution matches with the computational solution.



Plot of Square with diagonals