LINE ASSIGNMENT

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Problem Statement – A straight line L is perpendicular to the line 5x-y=1.The area of the triangle formed by the line and the coordinate axis is 5.Find the equation of line L.

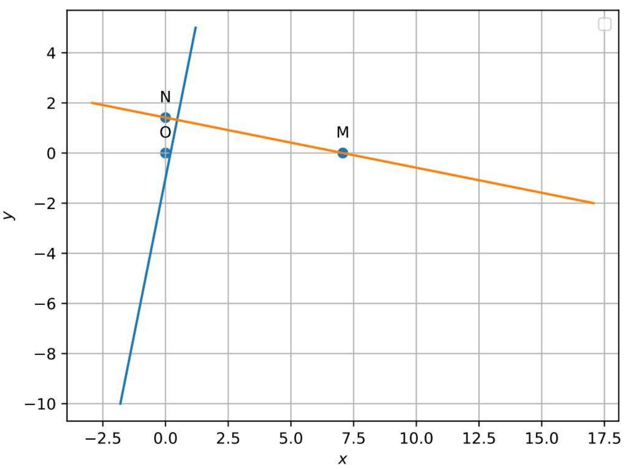

Figure 1: Perpendcular line

Construction

The input parameters are as follows

Symbol	Value	Description
$\mathbf{n_1}$	$\begin{pmatrix} 5 \\ -1 \end{pmatrix}$	normal vector
c_1	$\begin{pmatrix} 1 \end{pmatrix}$	constant
$\mathbf{n_2}$	$\begin{pmatrix} 1 \\ 5 \end{pmatrix}$	direction vector
e_1	$\begin{pmatrix} 1 \\ 0 \end{pmatrix}$	
e_1	$\begin{pmatrix} 1 \\ 0 \end{pmatrix}$	
M	$\begin{pmatrix} a \\ 0 \end{pmatrix}$	${e_1}^T(\mathbf{a})$
N	$\begin{pmatrix} 0 \\ b \end{pmatrix}$	${e_2}^T(\mathbf{b})$

solution

step 1

let the given equation is

$$\mathbf{n_1^T}\,(x) = c \tag{1}$$

Direction vectors of the perpendicular line is

$$\mathbf{n_1^T n_2} = 0 \tag{2}$$

$$\mathbf{n_2} = \begin{pmatrix} 1 \\ 5 \end{pmatrix} \tag{3}$$

The perpendicular line meets the coordinate axis at two points and forms a triangle with area Q=5
Let the two points be M,N and O is the origin

The two points lies on the line with direction vector m ,we get the condition

$$\mathbf{n_2^T}(\mathbf{M}) = \mathbf{n_2^T}(\mathbf{N}) \tag{4}$$

Solving the above two equations we get

a = 5b

substitute a=5b then the points become

$$\mathbf{M} = \begin{pmatrix} 5b \\ 0 \end{pmatrix} \mathbf{N} = \begin{pmatrix} 0 \\ b \end{pmatrix} \tag{5}$$

To find the value of b
Given the area of the triangle formed by the points OMN is Q

$$\mathbf{V_1} = \mathbf{O} - \mathbf{M}, \mathbf{V_2} = \mathbf{O} - \mathbf{N} \tag{6}$$

$$\frac{1}{2}\left\|(\mathbf{V_1}) \times (\mathbf{V_2})\right\| = Q$$

by solving we get

b = $\sqrt{2}$

To get the value of c_2

$$\mathbf{n_2^T}\,(M) = c_2 \tag{7}$$

we get

$$c_2 = 5\sqrt{2}$$

The final equation is

$$\mathbf{n_2^T}\left(x\right) = c_2 \tag{8}$$