

# L<sup>A</sup>T<sub>E</sub>X ASSIGNMENT 1

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Question 1.3.3  $D_1$  is a point on BC such that  $AD_1 \perp BC$  and  $AD_1$  is defined to be the altitude. Find the equations of the altitude  $BE_1$  and  $CF_1$  to the sides AC and AB respectively.

**Solution:**

Given:

$$\mathbf{A} = \begin{pmatrix} 1 \\ -1 \end{pmatrix} \quad \mathbf{B} = \begin{pmatrix} -4 \\ 6 \end{pmatrix} \quad \mathbf{C} = \begin{pmatrix} -3 \\ -5 \end{pmatrix} \quad (1)$$

Direction vector

$$\mathbf{m}_{AB} = \mathbf{B} - \mathbf{A} \quad (2)$$

$$= \begin{pmatrix} 1 \\ -1 \end{pmatrix} - \begin{pmatrix} -4 \\ 6 \end{pmatrix} \quad (3)$$

$$= \begin{pmatrix} 5 \\ -7 \end{pmatrix} \quad (4)$$

$$\mathbf{m}_{AC} = \mathbf{C} - \mathbf{A} \quad (5)$$

$$= \begin{pmatrix} 1 \\ -1 \end{pmatrix} - \begin{pmatrix} -3 \\ -5 \end{pmatrix} \quad (6)$$

$$= \begin{pmatrix} 4 \\ 4 \end{pmatrix} \quad (7)$$

Normal vector

$$\mathbf{n} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} \mathbf{m} \quad (8)$$

$$\mathbf{n}_{AB} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} \begin{pmatrix} 5 \\ -7 \end{pmatrix} \quad (9)$$

$$= \begin{pmatrix} 7 \\ 5 \end{pmatrix} \quad (10)$$

$$\mathbf{n}_{AC} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} \begin{pmatrix} 4 \\ 4 \end{pmatrix} \quad (11)$$

$$= \begin{pmatrix} 4 \\ -4 \end{pmatrix} \quad (12)$$

Equation of line is represented by:

$$\mathbf{n}^\top (\mathbf{x} - \mathbf{p}) = 0 \quad (13)$$

The equation of line  $CF_1$

$$\mathbf{n}_{AB}^\top (\mathbf{x} - \mathbf{C}) = 0 \quad (14)$$

$$\begin{pmatrix} -7 \\ 5 \end{pmatrix}^\top (\mathbf{x} - \begin{pmatrix} -3 \\ -5 \end{pmatrix}) = 0 \quad (15)$$

$$\begin{pmatrix} -7 & 5 \end{pmatrix} (\mathbf{x} - \begin{pmatrix} -3 \\ -5 \end{pmatrix}) = 0 \quad (16)$$

The equation of line  $BE_1$

$$\mathbf{n}_{AC}^\top (\mathbf{x} - \mathbf{B}) = 0 \quad (17)$$

$$\begin{pmatrix} 4 \\ -4 \end{pmatrix}^\top (\mathbf{x} - \begin{pmatrix} -4 \\ 6 \end{pmatrix}) = 0 \quad (18)$$

$$\begin{pmatrix} 4 & -4 \end{pmatrix} (\mathbf{x} - \begin{pmatrix} -4 \\ 6 \end{pmatrix}) = 0 \quad (19)$$