ASSIGNMENT-1

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Question 1.3.3

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

Solution: Given:

$$\mathbf{A} = \begin{pmatrix} 1 \\ -1 \end{pmatrix} \tag{1}$$

$$\mathbf{B} = \begin{pmatrix} -4 \\ 6 \end{pmatrix} \tag{2}$$

$$\mathbf{C} = \begin{pmatrix} -3 \\ -5 \end{pmatrix} \tag{3}$$

Direction vector

$$\mathbf{m}_{AB} = \mathbf{B} - \mathbf{A} \tag{4}$$

$$= \begin{pmatrix} -4 \\ 6 \end{pmatrix} - \begin{pmatrix} 1 \\ -1 \end{pmatrix} \tag{5}$$

$$= \begin{pmatrix} -5 \\ 7 \end{pmatrix} \tag{6}$$

$$\mathbf{m}_{AC} = \mathbf{C} - \mathbf{A} \tag{7}$$

$$= \begin{pmatrix} -3 \\ -5 \end{pmatrix} - \begin{pmatrix} 1 \\ -1 \end{pmatrix} \tag{8}$$

$$= \begin{pmatrix} -4 \\ -4 \end{pmatrix} \tag{9}$$

Normal vector of BE_1 is orthogonal to BE_1 and hence parallel to AC and normal vector of CF_1 is orthogonal to CF_1 and hence parallel to AB

$$\mathbf{n}_{BE_1} = \mathbf{m}_{AC} \tag{10}$$

$$= \begin{pmatrix} -5 \\ 7 \end{pmatrix} \tag{11}$$

$$\mathbf{n}_{CF_1} = \mathbf{m}_{AB} \tag{12}$$

$$= \begin{pmatrix} -4 \\ -4 \end{pmatrix} \tag{13}$$

Equation of line is represented by:

$$\mathbf{n}^\top(\mathbf{x} - \mathbf{p}) = 0 \tag{14}$$

1) The equation of line $\mathbf{CF_1}$

$$\mathbf{n}_{CF_1}^\top (\mathbf{x} - \mathbf{C}) = 0 \tag{15}$$

$$\begin{pmatrix} -5 \\ 7 \end{pmatrix}^\top \left(\mathbf{x} - \begin{pmatrix} -3 \\ -5 \end{pmatrix}\right) = 0 \tag{16}$$

$$\begin{pmatrix} -5 & 7 \end{pmatrix} \left(\mathbf{x} - \begin{pmatrix} -3 \\ -5 \end{pmatrix}\right) = 0 \tag{17}$$

$$\begin{pmatrix} -5 \\ 7 \end{pmatrix}^\top \mathbf{x} = -20 \tag{18}$$

2) The equation of line $\mathbf{BE_1}$

$$\mathbf{n}_{BE_1}^\top (\mathbf{x} - \mathbf{B}) = 0 \tag{19}$$

$$\begin{pmatrix} -4 \\ -4 \end{pmatrix}^\top \left(\mathbf{x} - \begin{pmatrix} -4 \\ 6 \end{pmatrix}\right) = 0 \tag{20}$$

$$\begin{pmatrix} -4 & -4 \end{pmatrix} \left(\mathbf{x} - \begin{pmatrix} -4 \\ 6 \end{pmatrix}\right) = 0 \tag{21}$$

$$\begin{pmatrix} -4 \\ -4 \end{pmatrix}^\top \mathbf{x} = -8 \tag{22}$$

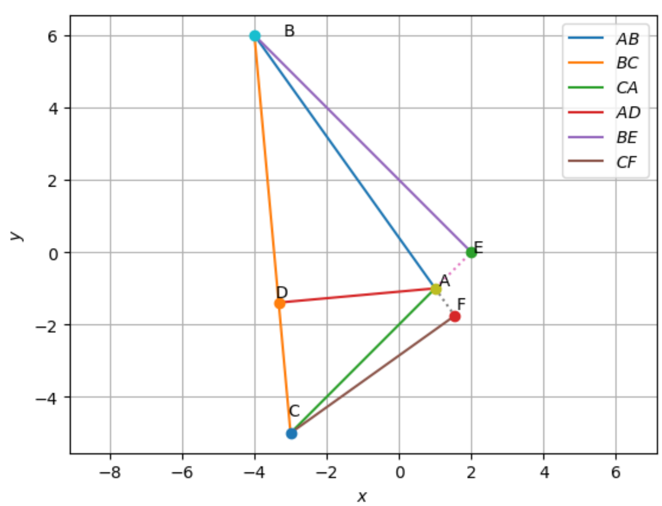

Fig. 2. Lines $\mathbf{BE}_1$ and $\mathbf{CF}_1$