

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

$$\mathbf{n} = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} \mathbf{m}$$

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

$$= \begin{pmatrix} 7 \\ 5 \end{pmatrix}$$

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

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

1) The equation of line CF_1

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

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

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

$$\begin{pmatrix} -7 \\ 5 \end{pmatrix}^T \mathbf{x} = -4 \quad (17)$$

2) The equation of line BE_1

$$\mathbf{n}_{AC}^T (\mathbf{x} - \mathbf{B}) = 0 \quad (18)$$

$$\begin{pmatrix} 4 \\ -4 \end{pmatrix}^T \left(\mathbf{x} - \begin{pmatrix} -4 \\ 6 \end{pmatrix} \right) = 0 \quad (19)$$

$$\begin{pmatrix} 4 & -4 \end{pmatrix} \left(\mathbf{x} - \begin{pmatrix} -4 \\ 6 \end{pmatrix} \right) = 0 \quad (20)$$

$$\begin{pmatrix} 4 \\ -4 \end{pmatrix}^T \mathbf{x} = -40 \quad (21)$$

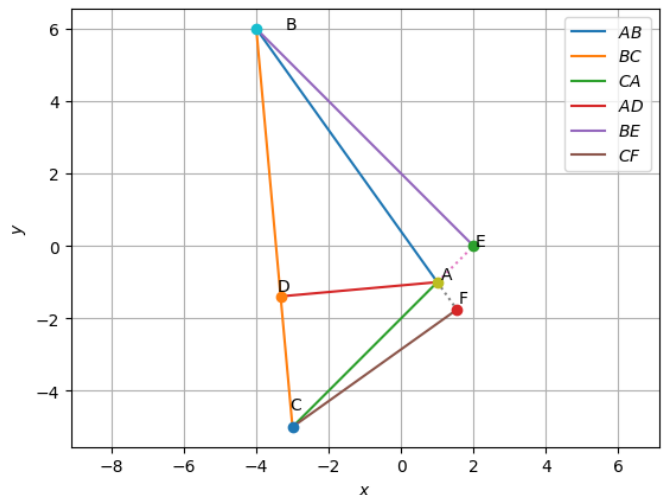


Fig. 2. Points BE and CF plotted using python

Equation of line is represented by:

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