

# Assignment 2

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## Question:

A(2,5), B(-1,2) and C(5,8) are the vertices of the triangle  $ABC$ , M is a point on  $AB$  such that  $AM:MB = 1:2$ . Find the co-ordinates of M. Hence find the equation of line passing through the points C and M.

**Solution:** Given, A, B, C form a triangle  $ABC$ .

$$A = \begin{pmatrix} 2 \\ 5 \end{pmatrix}, B = \begin{pmatrix} -1 \\ 2 \end{pmatrix}, C = \begin{pmatrix} 5 \\ 8 \end{pmatrix} \quad (1)$$

Let R divides  $\overrightarrow{PQ}$  internally in the ratio of  $k : 1$  i.e.,  $\frac{\overrightarrow{PR}}{\overrightarrow{RQ}} = \frac{k}{1}$  such that

$$\vec{a} = \overrightarrow{OP} \quad (2)$$

$$\vec{b} = \overrightarrow{OQ} \quad (3)$$

$$\vec{r} = \overrightarrow{OR} \quad (4)$$

Then, we get

$$\vec{r} = \frac{k\vec{b} + 1\vec{a}}{k + 1} \quad (5)$$

Given, M is a point on side  $AB$  such that  $AM : MB = 1 : 2$ . Using (5), we get

$$\vec{m} = \frac{\vec{b} + 2\vec{a}}{3} \quad (6)$$

On substituting, we get

$$M = \frac{\begin{pmatrix} -1 \\ 2 \end{pmatrix} + 2\begin{pmatrix} 2 \\ 5 \end{pmatrix}}{3} \quad (7)$$

$$\Rightarrow M = \begin{pmatrix} 1 \\ 4 \end{pmatrix}. \quad (8)$$

Let L be the line that passes through points  $C \begin{pmatrix} 5 \\ 8 \end{pmatrix}$ ,

The direction vector of  $CM$  is,

$$\mathbf{m} = \mathbf{C} - \mathbf{M} \quad (9)$$

$$\Rightarrow \mathbf{m} = \begin{pmatrix} 5 \\ 8 \end{pmatrix} - \begin{pmatrix} 1 \\ 4 \end{pmatrix} \quad (10)$$

$$\Rightarrow \mathbf{m} = \begin{pmatrix} 4 \\ 4 \end{pmatrix} \quad (11)$$

Normal vector of the line is  $\mathbf{n}$ , such that

$$\mathbf{m}^\top \mathbf{n} = 0 \quad (12)$$

$$\Rightarrow \begin{pmatrix} 4 & 4 \end{pmatrix} \mathbf{n} = 0 \quad (13)$$

$$\Rightarrow \mathbf{n} = \begin{pmatrix} 1 \\ -1 \end{pmatrix} \quad (14)$$

$$\Rightarrow \mathbf{n}^\top = \begin{pmatrix} 1 & -1 \end{pmatrix} \quad (15)$$

The normal equation of the line L is given by,

$$\mathbf{n}^\top (\mathbf{x} - \mathbf{M}) = 0 \quad (16)$$

$$\Rightarrow \begin{pmatrix} 1 & -1 \end{pmatrix} \left( \mathbf{x} - \begin{pmatrix} 1 \\ 4 \end{pmatrix} \right) = 0 \quad (17)$$

$$\Rightarrow \begin{pmatrix} 1 & -1 \end{pmatrix} \mathbf{x} = -3 \quad (18)$$

Thus, the equation of line L passing through  $C \begin{pmatrix} 5 \\ 8 \end{pmatrix}$  and  $M \begin{pmatrix} 1 \\ 4 \end{pmatrix}$  is

$$\begin{pmatrix} 1 & -1 \end{pmatrix} \mathbf{x} + 3 = 0 \quad (19)$$

which can also be represented as

$$x - y + 3 = 0 \quad (20)$$

But, However, We get

1) The equation of the line joining  $A \begin{pmatrix} 2 \\ 5 \end{pmatrix}$ ,

$B \begin{pmatrix} -1 \\ 2 \end{pmatrix}$  as  $\begin{pmatrix} 1 & -1 \end{pmatrix} \mathbf{x} = -3$ .

2) The equation of the line joining  $B \begin{pmatrix} -1 \\ 2 \end{pmatrix}$ ,

$C \begin{pmatrix} 5 \\ 8 \end{pmatrix}$  as  $\begin{pmatrix} 1 & -1 \end{pmatrix} \mathbf{x} = -3$  too.

Now, Let's find the area of triangle to verify if the points are collinear: Given,

$$\mathbf{A} = \begin{pmatrix} 2 \\ 5 \end{pmatrix}, \mathbf{B} = \begin{pmatrix} -1 \\ 2 \end{pmatrix}, \mathbf{C} = \begin{pmatrix} 5 \\ 8 \end{pmatrix} \quad (21)$$

are the vertices of triangle.

$$\mathbf{A} - \mathbf{B} = \begin{pmatrix} 3 \\ 3 \end{pmatrix}, \quad (22)$$

$$\mathbf{A} - \mathbf{C} = \begin{pmatrix} -3 \\ -3 \end{pmatrix}, \quad (23)$$

The desired area is the magnitude of

$$\begin{vmatrix} 3 & -3 \\ 3 & -3 \end{vmatrix} \quad (24)$$

Thus the desired area is 0 units.

Hence, Given points  $\mathbf{A}, \mathbf{B}, \mathbf{C}$  don't form a triangle.

Also Verified by plotting the graph of  $\mathbf{A}, \mathbf{B}, \mathbf{C}$  and  $\mathbf{M}$  points :

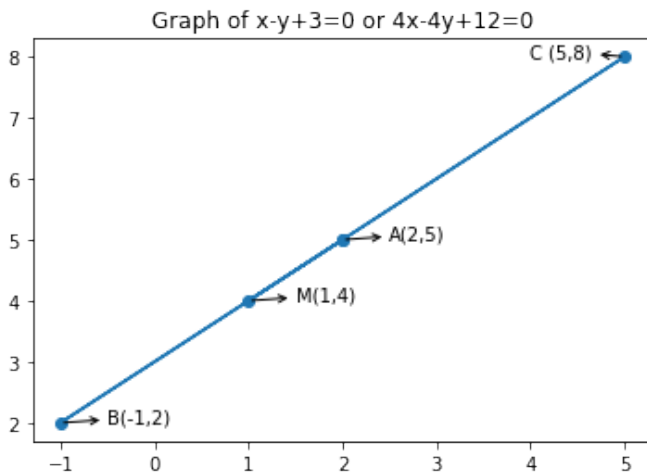


Fig. 1. Graph showing that the points  $\mathbf{A}, \mathbf{B}, \mathbf{C}, \mathbf{M}$  lie on the same line.