

# Assignment 1

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Download all python codes from

[https://github.com/Dhatri-nanda/EE3900/blob/main/Assignment\\_1/code.py](https://github.com/Dhatri-nanda/EE3900/blob/main/Assignment_1/code.py)

and latex-tikz codes from

[https://github.com/Dhatri-nanda/EE3900/blob/main/Assignment\\_1/Assignment\\_1.tex](https://github.com/Dhatri-nanda/EE3900/blob/main/Assignment_1/Assignment_1.tex)

## 1 PROBLEM

Prove that the points  $\begin{pmatrix} 21 \\ -2 \end{pmatrix}$ ,  $\begin{pmatrix} 15 \\ 10 \end{pmatrix}$ ,  $\begin{pmatrix} -5 \\ 0 \end{pmatrix}$ ,  $\begin{pmatrix} 1 \\ -12 \end{pmatrix}$  are the vertices of a rectangle, and find the coordinates of its centre.

## 2 SOLUTION

Let's name the points as A,B,C and D respectively i.e.,

$$A = \begin{pmatrix} 21 \\ -2 \end{pmatrix} B = \begin{pmatrix} 15 \\ 10 \end{pmatrix} C = \begin{pmatrix} -5 \\ 0 \end{pmatrix} D = \begin{pmatrix} 1 \\ -12 \end{pmatrix} \quad (2.0.1)$$

Now, the first criteria for a quadrilateral to be a rectangle is that the diagonals bisect each other but not with right angles. Next, we check if the angle between sides is right angle.

Finding midpoints of both the diagonals, to see if they bisect each other.

Midpoint of diagonal AC

$$= \frac{A + C}{2} \quad (2.0.2)$$

From (2.0.1)

$$= \begin{pmatrix} 8 \\ -1 \end{pmatrix} \quad (2.0.3)$$

Midpoint of diagonal AD

$$= \frac{B + D}{2} \quad (2.0.4)$$

From (2.0.1)

$$= \begin{pmatrix} 8 \\ -1 \end{pmatrix} \quad (2.0.5)$$

As the midpoints are equal, they bisect each other. Let the midpoint be O.

Now we check the angle between diagonals

$$(\mathbf{A} - \mathbf{O})^T (\mathbf{C} - \mathbf{O}) = \begin{pmatrix} 13 & -1 \end{pmatrix} \begin{pmatrix} -13 \\ 1 \end{pmatrix} \quad (2.0.6)$$

$$= -170 \quad (2.0.7)$$

$$\neq 0 \quad (2.0.8)$$

Therefore, the diagonals do not intersect at right angles.

The angle between sides

$$\angle B = (\mathbf{B} - \mathbf{A})^T (\mathbf{C} - \mathbf{B}) \quad (2.0.9)$$

$$= \begin{pmatrix} -6 & 12 \end{pmatrix} \begin{pmatrix} -20 \\ -10 \end{pmatrix} \quad (2.0.10)$$

$$= 0 \quad (2.0.11)$$

Therefore, one of the angle is right angle.

As the diagonals bisect each other, by congruency of the inner triangles formed, we can observe that remaining angles are also 90 degrees.

Therefore, the vertices form a rectangle.

The center of the rectangle from above is O i.e.,

$$O = \begin{pmatrix} 8 \\ -1 \end{pmatrix} \quad (2.0.12)$$

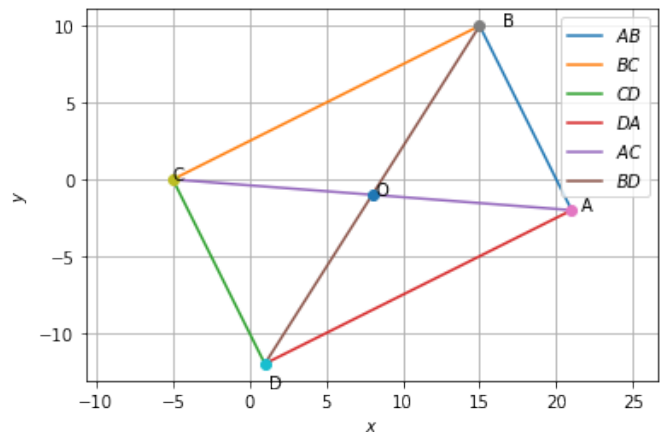


Fig. 0: plot