

# Assignment 1

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## Chapter II, Examples II

**Q22 (iii) Find the conditions that the four points**

$\begin{pmatrix} x_1 \\ y_1 \end{pmatrix}, \begin{pmatrix} x_2 \\ y_2 \end{pmatrix}, \begin{pmatrix} x_3 \\ y_3 \end{pmatrix}, \begin{pmatrix} x_4 \\ y_4 \end{pmatrix}$   
may be the vertices of a rhombus.

**Solution :**

The given points are

$$\mathbf{A} = \begin{pmatrix} x_1 \\ y_1 \end{pmatrix}, \mathbf{B} = \begin{pmatrix} x_2 \\ y_2 \end{pmatrix},$$

$$\mathbf{C} = \begin{pmatrix} x_3 \\ y_3 \end{pmatrix}, \mathbf{D} = \begin{pmatrix} x_4 \\ y_4 \end{pmatrix},$$

Conditions for the given four points to be the vertices of a rhombus are:

1. If opposite sides are parallel and
2. If diagonals are perpendicular .

if

$$(\mathbf{A} - \mathbf{B}) = k(\mathbf{D} - \mathbf{C}) \quad (1)$$

$$(\mathbf{B} - \mathbf{C}) = k(\mathbf{A} - \mathbf{D}) \quad (2)$$

here k is any integer. (1) shows

$$AB \parallel DC$$

(2) shows

$$BC \parallel AD$$

if

$$(\mathbf{A} - \mathbf{C})^\top (\mathbf{B} - \mathbf{D}) = 0 \quad (3)$$

(3) shows

$$AC \perp BD$$

As the given four points satisfy the required conditions we can say that they are the vertices of a rhombus.

**Numerical Example :**

Examine whether the given points A (2,-3) and B (6,5) and C (-2,1) and D (-6,-7) forms a rhombus.

**Sol:** The given points are

$$\mathbf{A} = \begin{pmatrix} 2 \\ -3 \end{pmatrix}, \mathbf{B} = \begin{pmatrix} 6 \\ 5 \end{pmatrix}, \quad (4)$$

$$\mathbf{C} = \begin{pmatrix} -2 \\ 1 \end{pmatrix}, \mathbf{D} = \begin{pmatrix} -6 \\ -7 \end{pmatrix} \quad (5)$$

$$(\mathbf{A} - \mathbf{B}) = \begin{pmatrix} -4 \\ -8 \end{pmatrix}, (\mathbf{D} - \mathbf{C}) = \begin{pmatrix} -4 \\ -8 \end{pmatrix} \quad (6)$$

$$(\mathbf{B} - \mathbf{C}) = \begin{pmatrix} 8 \\ 4 \end{pmatrix}, (\mathbf{A} - \mathbf{D}) = \begin{pmatrix} 8 \\ 4 \end{pmatrix} \quad (7)$$

$$(\mathbf{A} - \mathbf{B}) = (\mathbf{D} - \mathbf{C}) \quad (8)$$

$$(\mathbf{B} - \mathbf{C}) = (\mathbf{A} - \mathbf{D}) \quad (9)$$

As k=1 in (8) and (9)

(8) shows

$$AB \parallel DC$$

and (9) shows

$$BC \parallel AD$$

$$(\mathbf{A} - \mathbf{C})^\top (\mathbf{B} - \mathbf{D}) = 0 \quad (3) \quad (\mathbf{A} - \mathbf{C})^\top = \begin{pmatrix} 4 & -4 \end{pmatrix}, (\mathbf{B} - \mathbf{D}) = \begin{pmatrix} 12 \\ 12 \end{pmatrix} \quad (10)$$

$$(\mathbf{A} - \mathbf{C})^\top (\mathbf{B} - \mathbf{D}) = 48 - 48 = 0 \quad (11)$$

(11) shows

$$AC \perp BD$$

Given points A,B,C,D satisfy the required conditions hence they form a Rhombus.

Rhombus is drawn using python

[https://github.com/Srikanth1408/Assignment\\_1/blob/main/Assignment1.ipynb](https://github.com/Srikanth1408/Assignment_1/blob/main/Assignment1.ipynb)

