

MATRICES USING PYTHON

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IITH Future Wireless Communication (FWC)

ASSIGN-4

Contents

1 Problem

2 Construction

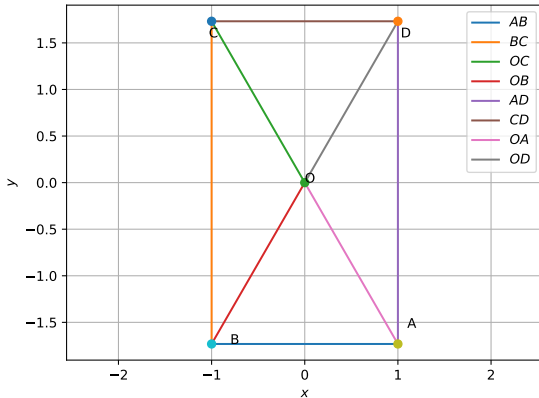
3 Solution

1 Problem

If diagonals of a parallelogram are equal then show that it is a rectangle

2 Construction

Figure of Construction



The input parameters for this construction are

Symbol	Value	Description
r	6	AC
k	4	AB
θ	$\arccos(k/r)$	$\angle AC$
A	$\begin{pmatrix} 0 \\ 0 \end{pmatrix}$	Point A

3 Solution

Termux commands :

python3 matrixline.py

To Prove: ABCD is a rectangle

Given: ABCD is a parallelogram

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

And, Diagonals of the parallelogram are equal.

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

Now, we should prove that its a rectangle i.e

$$\theta = 90 \quad (3)$$

$$\cos \theta_1 = \frac{(\mathbf{A} - \mathbf{B})^T (\mathbf{B} - \mathbf{C})}{\|(\mathbf{A} - \mathbf{B})\| \|(\mathbf{B} - \mathbf{C})\|} \quad (4)$$

$$(\mathbf{A} - \mathbf{B})^T (\mathbf{B} - \mathbf{C}) = 0 \quad (5)$$

$$(6)$$

from equation (2)

$$\|\mathbf{C} - \mathbf{A}\|^2 = \|\mathbf{D} - \mathbf{B}\|^2$$

$$\|(\mathbf{A} - \mathbf{B}) + (\mathbf{B} - \mathbf{C})\|^2 = \|(\mathbf{A} - \mathbf{B}) + (\mathbf{B} - \mathbf{C})\|^2$$

After resolving the above equation

$$2(\mathbf{A} - \mathbf{B})^T (\mathbf{B} - \mathbf{C}) = 2(\mathbf{C} - \mathbf{D})^T (\mathbf{B} - \mathbf{C}) \quad (7)$$

according to parallelogram theorem, we can write $\mathbf{C} - \mathbf{D} = -(\mathbf{A} - \mathbf{B})$

$$2(\mathbf{A} - \mathbf{B})^T (\mathbf{B} - \mathbf{C}) = -2(\mathbf{A} - \mathbf{B})^T (\mathbf{B} - \mathbf{C}) \quad (8)$$

$$2(\mathbf{A} - \mathbf{B})^T (\mathbf{B} - \mathbf{C}) + 2(\mathbf{A} - \mathbf{B})^T (\mathbf{B} - \mathbf{C}) = 0 \quad (9)$$

$$2(\mathbf{A} - \mathbf{B})^T (\mathbf{B} - \mathbf{C}) = 0 \quad (10)$$

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

$$\Rightarrow \cos \theta = 0 \quad (12)$$

$$\theta = 90 \quad (13)$$

\therefore It is a rectangle

The below python code realizes the above construction:

https://github.com/Rahulraj00/Assignments/tree/main/Assignments/assg_4