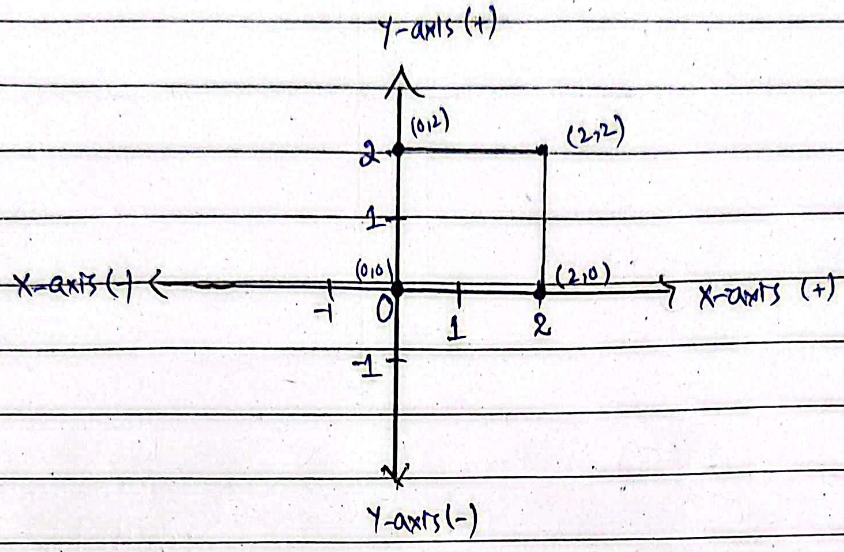
ROLL NO: 25I-7601 BY: TILA MUHAMMAD

DATE: 26/08/2025 MATH FOUNDATION OF AI DAY: / /

GIVEN You are given ~~two~~ the vertices of a simple 2D Square.
(0,0), (0,2), (2,0), (2,2)

SOLUTION:

a) Plotting the original square in the x-y-plane.



b) Representation of the vertices as Vectors in the form of a column vector.

$$V_1 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \quad V_2 = \begin{bmatrix} 0 \\ 2 \end{bmatrix}, \quad V_3 = \begin{bmatrix} 2 \\ 0 \end{bmatrix}, \quad V_4 = \begin{bmatrix} 2 \\ 2 \end{bmatrix}$$

c) we have a matrix $A = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$. To calculate the new values of the vertices, we are going to multiply A with each column vector (in part b).

★ $AV_1 = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \end{bmatrix} \Rightarrow \begin{bmatrix} 0+0 \\ 0+0 \end{bmatrix} \Rightarrow \begin{bmatrix} 0 \\ 0 \end{bmatrix} \Rightarrow (0,0)$

★ $AV_2 = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} 0 \\ 2 \end{bmatrix} \Rightarrow \begin{bmatrix} 0-2 \\ 0+0 \end{bmatrix} \Rightarrow \begin{bmatrix} -2 \\ 0 \end{bmatrix} \Rightarrow (-2,0)$

★ $AV_3 = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} 2 \\ 0 \end{bmatrix} \Rightarrow \begin{bmatrix} 0+0 \\ 2+0 \end{bmatrix} \Rightarrow \begin{bmatrix} 0 \\ 2 \end{bmatrix} \Rightarrow (0,2)$

★ $AV_4 = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} 2 \\ 2 \end{bmatrix} \Rightarrow \begin{bmatrix} 0-2 \\ 2+0 \end{bmatrix} \Rightarrow \begin{bmatrix} -2 \\ 2 \end{bmatrix} \Rightarrow (-2,2)$

new values

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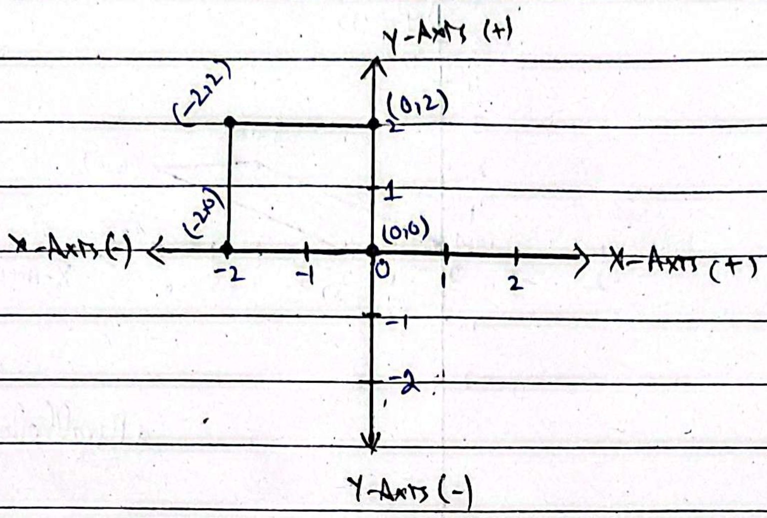
d) Plotting the new values after transformation:

New values = $(0,0), (-2,0), (0,2), (-2,2)$



e) Interpretation: ~~From~~ From the new plot, we can interpret ~~see~~ that a 90°-clockwise rotation moves the square to a new position, in our case it is placed from Quadrant I to Quadrant II, without changing the angles, lengths and areas.

F) Now we have a matrix, $B = \begin{pmatrix} 1 & 2 \\ 0 & 1 \end{pmatrix}$. To calculate the new values of the vertices, we are going to multiply B with each column vector.

★ $BV_1 = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \end{bmatrix} \Rightarrow \begin{bmatrix} 0+0 \\ 0+0 \end{bmatrix} \Rightarrow \begin{bmatrix} 0 \\ 0 \end{bmatrix} \Rightarrow (0,0)$

★ $BV_2 = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 2 \end{bmatrix} \Rightarrow \begin{bmatrix} 0+4 \\ 0+2 \end{bmatrix} \Rightarrow \begin{bmatrix} 4 \\ 2 \end{bmatrix} \Rightarrow (4,2)$

★ $BV_3 = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 0 \end{bmatrix} \Rightarrow \begin{bmatrix} 2+0 \\ 0+0 \end{bmatrix} \Rightarrow \begin{bmatrix} 2 \\ 0 \end{bmatrix} \Rightarrow (2,0)$

★ $BV_4 = \begin{bmatrix} 1 & 2 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 2 \end{bmatrix} \Rightarrow \begin{bmatrix} 2+4 \\ 0+2 \end{bmatrix} \Rightarrow \begin{bmatrix} 6 \\ 2 \end{bmatrix} \Rightarrow (6,2)$

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New Values

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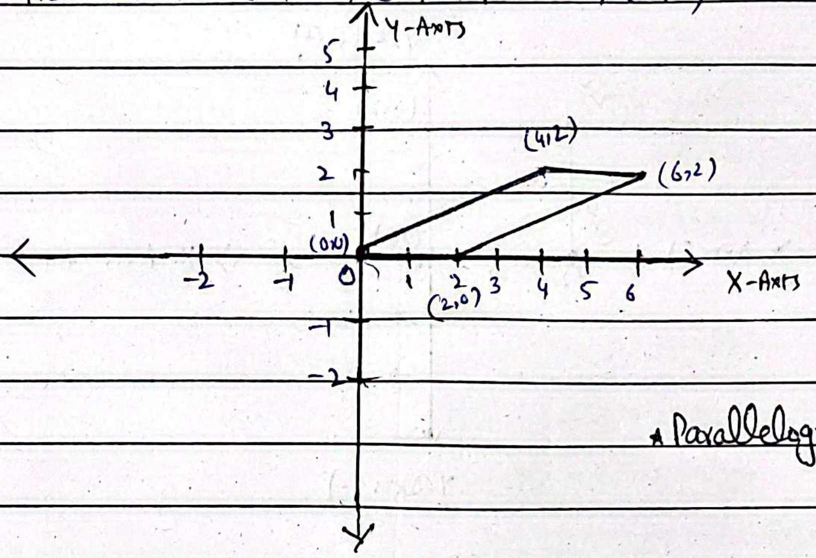
g) Plotting the new values in XY-plane.

New values = (0,0), (4,2), (2,0), (6,2)



* Parallelogram (Formed)

h) Interpretation:-

From the above plot (part g), we can interpret that the amount of space or area inside the shape doesn't change and ~~it~~ ~~is~~ also preserves parallelism. ~~Or~~ Additionally, ~~the~~ angles and ~~the~~ lengths ~~does~~ changes while the base remains fixed.