Ans to the ques no: 1

Here, $A(0,0,4)$ is translated to $A_1^*(2,3,6)$

Therefore,
$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & T_x \\ 0 & 1 & 0 & T_y \\ 0 & 0 & 1 & T_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 2 \\ 3 \\ 6 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & T_x \\ 0 & 1 & 0 & T_y \\ 0 & 0 & 1 & T_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 4 \\ 1 \end{bmatrix}$$

$$\therefore \begin{bmatrix} 2 \\ 3 \\ 6 \\ 1 \end{bmatrix} = \begin{bmatrix} T_x \\ T_y \\ 4 + T_z \\ 1 \end{bmatrix}$$

So, $T_x = 2$

$T_y = 3$

$T_z = 6 - 4 = 2$

$$\therefore \text{Translation matrix} = \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

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Following the translation matrix,

coordinate of O_1:
$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} 2 \\ 3 \\ 2 \\ 1 \end{bmatrix}$$

$\therefore$ The new point is at $O_1 (2, 3, 2)$.

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Ans to the ques no:- 2

Considering the Center of Rotation to be at $O_1(2,3,2)$, we need to firstly shift the corner points in such way that the Center of Rotation lies at the origin. Then, we need to rotate. Finally we will retranslate to original position.

Here, if O_1 is translated to origin, the whole Figure-2 will shift to be Figure-1. Now, we will rotate Figure-1. The rotated points by 30°:

$$A_2' = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos 30^\circ & -\sin 30^\circ & 0 \\ 0 & \sin 30^\circ & \cos 30^\circ & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 0 \\ 0 \\ 4 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ -2 \\ 2\sqrt{3} \\ 1 \end{bmatrix}$$

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$$B_2^1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos 30^\circ & -\sin 30^\circ & 0 \\ 0 & \sin 30^\circ & \cos 30^\circ & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 0 \\ 4 \\ 2 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ -1+2\sqrt{3} \\ 2+\sqrt{3} \\ 1 \end{bmatrix}$$

$$C_2^1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos 30^\circ & -\sin 30^\circ & 0 \\ 0 & \sin 30^\circ & \cos 30^\circ & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 2 \\ 4 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 2 \\ 2\sqrt{3} \\ 2 \\ 1 \end{bmatrix}$$

$$D_2^1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos 30^\circ & -\sin 30^\circ & 0 \\ 0 & \sin 30^\circ & \cos 30^\circ & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 2 \\ 2 \\ 4 \\ 1 \end{bmatrix} = \begin{bmatrix} 2 \\ -2+\sqrt{3} \\ 1+2\sqrt{3} \\ 1 \end{bmatrix}$$

$$O_2^1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos 30^\circ & -\sin 30^\circ & 0 \\ 0 & \sin 30^\circ & \cos 30^\circ & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

$$F_2^1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos 30^\circ & -\sin 30^\circ & 0 \\ 0 & \sin 30^\circ & \cos 30^\circ & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 0 \\ 0 \\ 2 \\ 1 \end{bmatrix} = \begin{bmatrix} 0 \\ -1 \\ \sqrt{3} \\ 1 \end{bmatrix}$$

$$G_2^1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos 30^\circ & -\sin 30^\circ & 0 \\ 0 & \sin 30^\circ & \cos 30^\circ & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 2 \\ 0 \\ 2 \\ 1 \end{bmatrix} = \begin{bmatrix} 2 \\ -1 \\ \sqrt{3} \\ 1 \end{bmatrix}$$

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$$E_2' = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos 30^\circ & -\sin 30^\circ & 0 \\ 0 & \sin 30^\circ & \cos 30^\circ & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 2 \\ 0 \\ 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 2 \\ 0 \\ 0 \\ 1 \end{bmatrix}$$

Finally, applying the transition matrics to all the interim points :-

$$A2 = \begin{bmatrix} 1 & 0 & 0 & 2 \\ 0 & 1 & 0 & 3 \\ 0 & 0 & 1 & 2 \\ 0 & 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 0 \\ -2 \\ 2\sqrt{3} \\ 1 \end{bmatrix} = \begin{bmatrix} 2 \\ 1 \\ 2\sqrt{3}+2 \\ 1 \end{bmatrix}$$

$$= \begin{bmatrix} 2 \\ 1 \\ 5.46 \\ 1 \end{bmatrix}$$

Similarly,

$$B_2 = \begin{bmatrix} 2 \\ 5.46 \\ 5.73 \\ 1 \end{bmatrix}, \quad C_2 = \begin{bmatrix} 4 \\ 6.46 \\ 4 \\ 1 \end{bmatrix}$$

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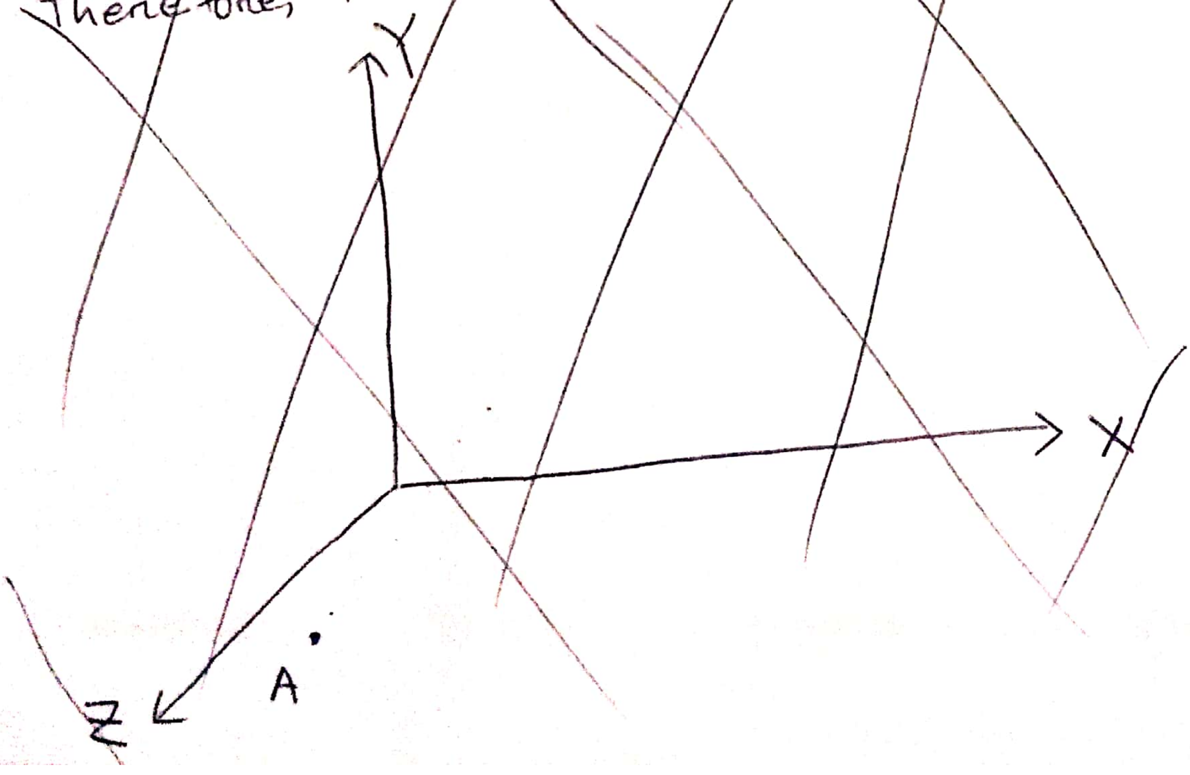
$$D_2 = \begin{bmatrix} 4 \\ 2.73 \\ 5.46 \\ 1 \end{bmatrix}, \quad C_2 = \begin{bmatrix} 2 \\ 3 \\ 2 \\ 1 \end{bmatrix}$$

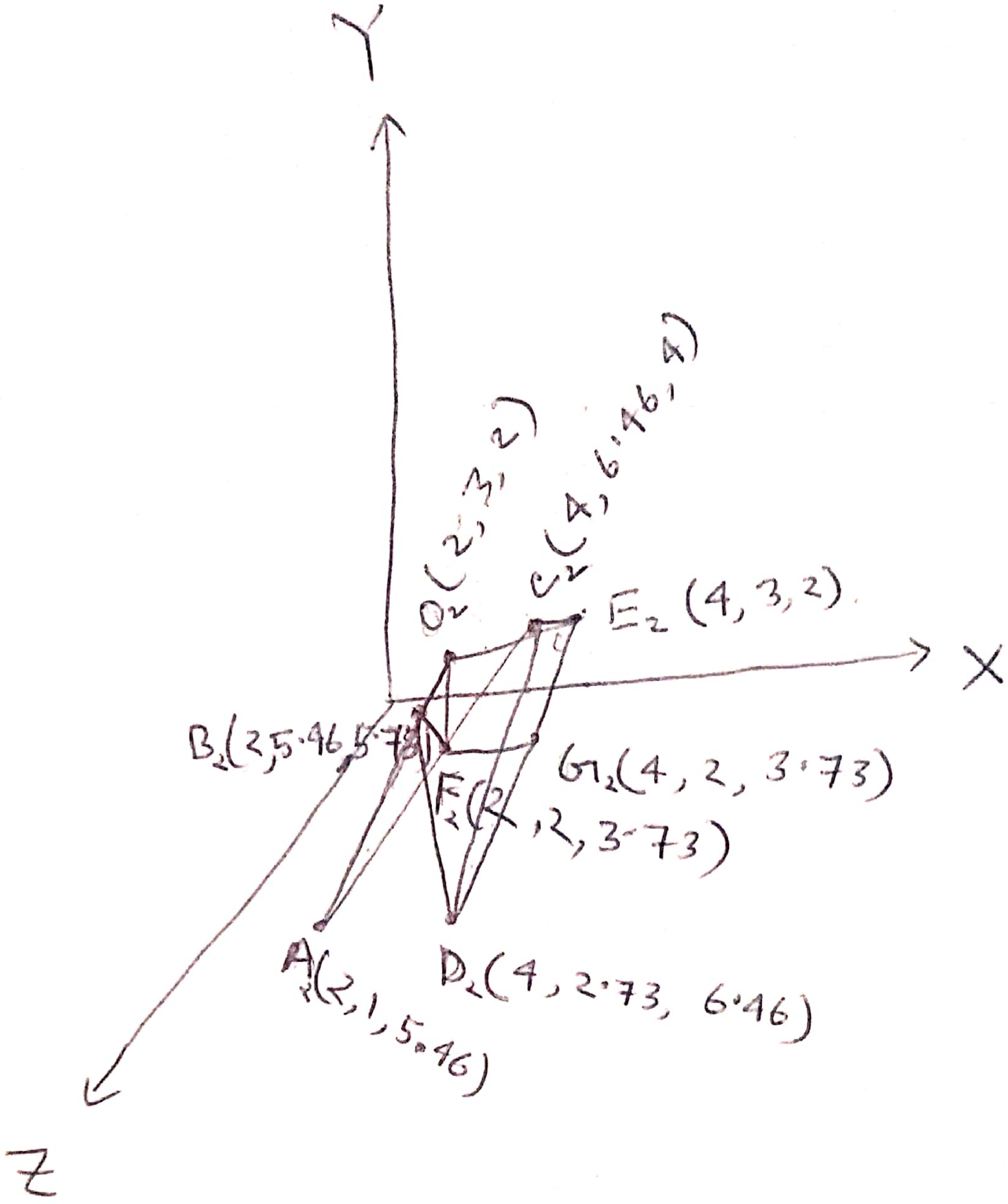
$$F_2 = \begin{bmatrix} 2 \\ 2 \\ 3.73 \\ 1 \end{bmatrix}, \quad G_2 = \begin{bmatrix} 4 \\ 2 \\ 3.73 \\ 1 \end{bmatrix}$$

$$E_2 = \begin{bmatrix} 4 \\ 3 \\ 2 \\ 1 \end{bmatrix}$$

Therefore, the Figure-3 will be,



The figure will be,



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