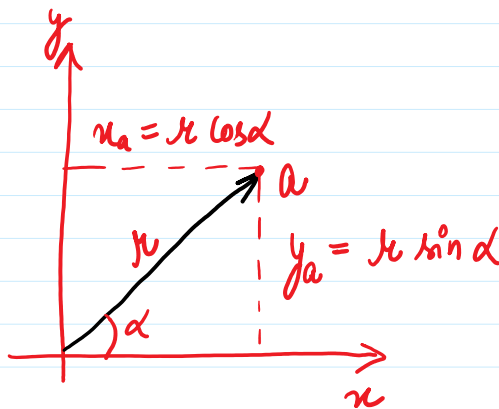
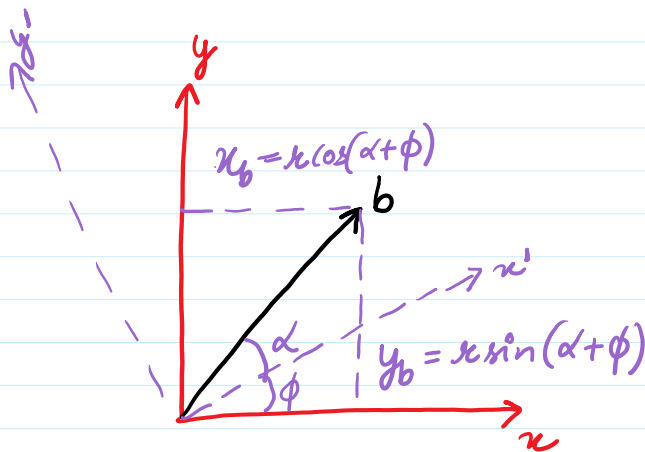


# Rotation :-



$$\begin{aligned} x_a &= r \cos \alpha & \text{--- (1)} \\ y_a &= r \sin \alpha \end{aligned}$$



$$x_b = r \cos(\alpha + \phi) = r \cos \alpha \cos \phi - r \sin \alpha \sin \phi$$

$$y_b = r \sin(\alpha + \phi) = r \sin \alpha \cos \phi + r \cos \alpha \sin \phi$$

from eq (1)

$$x_b = x_a \cos \phi - y_a \sin \phi$$

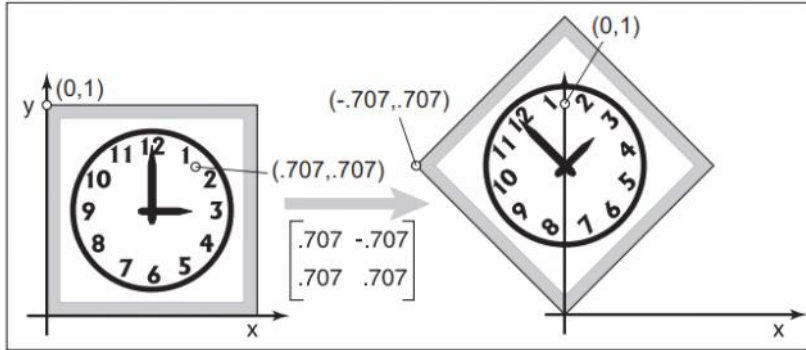
$$y_b = y_a \cos \phi + x_a \sin \phi$$

$$\begin{bmatrix} \cos \phi & -\sin \phi \\ \sin \phi & \cos \phi \end{bmatrix} \begin{bmatrix} x_a \\ y_a \end{bmatrix} = \begin{bmatrix} x_b \\ y_b \end{bmatrix}$$

⇒ Let  $\phi = +45^\circ$

$$\begin{bmatrix} \cos 45^\circ & -\sin 45^\circ \end{bmatrix}$$

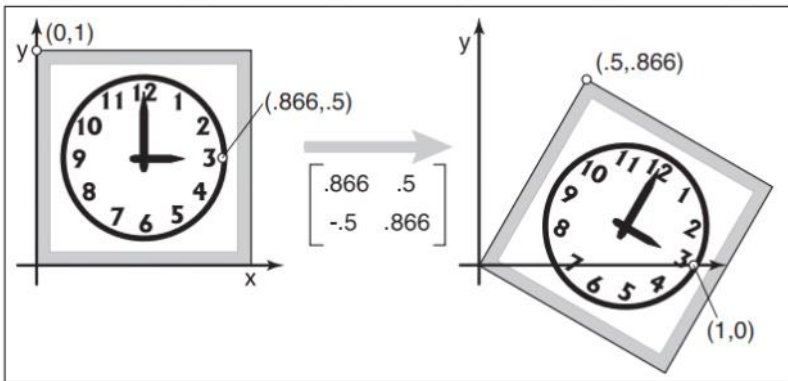
$$\begin{bmatrix} \cos 45^\circ & -\sin 45^\circ \\ \sin 45^\circ & \cos 45^\circ \end{bmatrix}$$



$\Rightarrow$  Let  $\phi = -30^\circ$

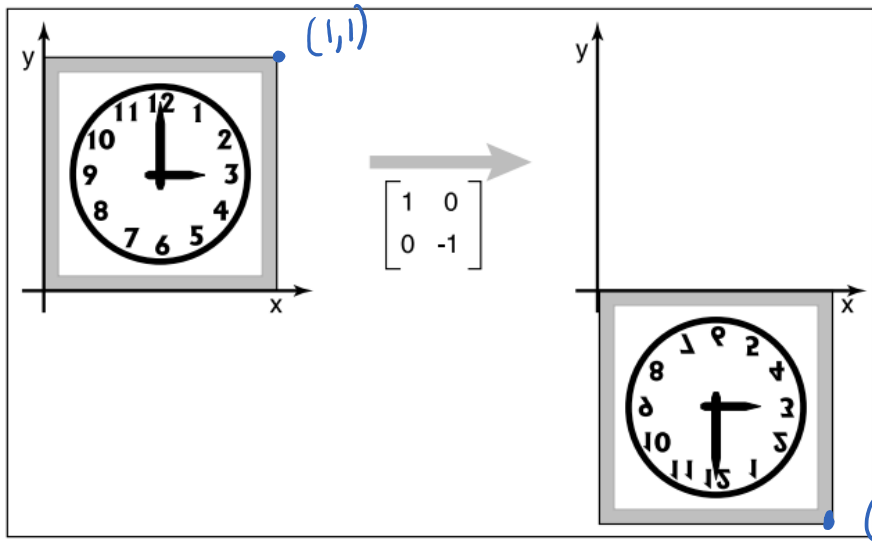
$$\begin{bmatrix} \cos(-30^\circ) & -\sin(-30^\circ) \\ \sin(-30^\circ) & \cos(-30^\circ) \end{bmatrix}$$

$$= \begin{bmatrix} \cos 30^\circ & \sin 30^\circ \\ -\sin 30^\circ & \cos 30^\circ \end{bmatrix}$$



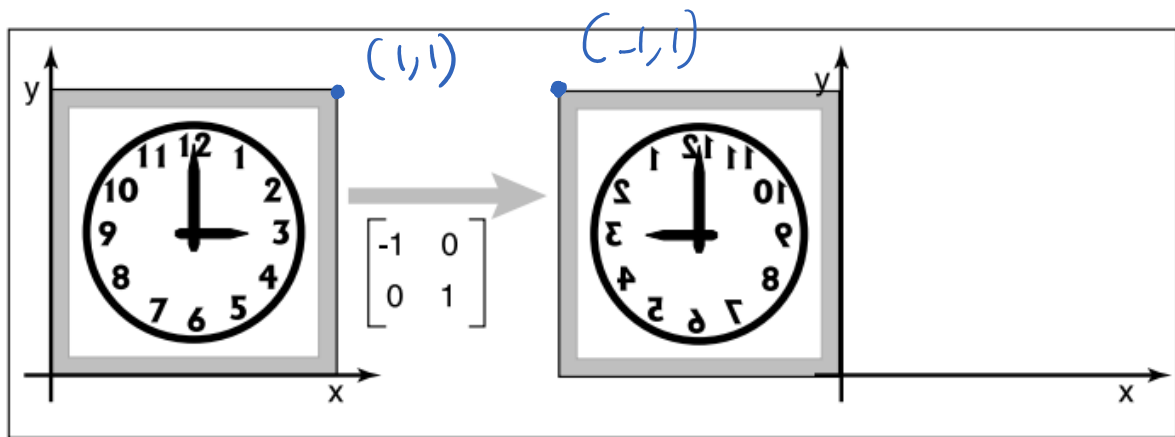
Reflection :-

About x-axis, reflect-x =  $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$



$$\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

About y-axis, reflect  $-y = \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$



Compositions of Transformations :-

Applying more than one transformations.

Let  $R =$  Rotation Matrix  
 $S =$  Scale Matrix

$$v_1 \rightarrow Sv_1 \rightarrow Rv_2$$

$$\overline{v_2} \quad \overline{v_3}$$

$$\Rightarrow v_3 = R(Sv_1)$$

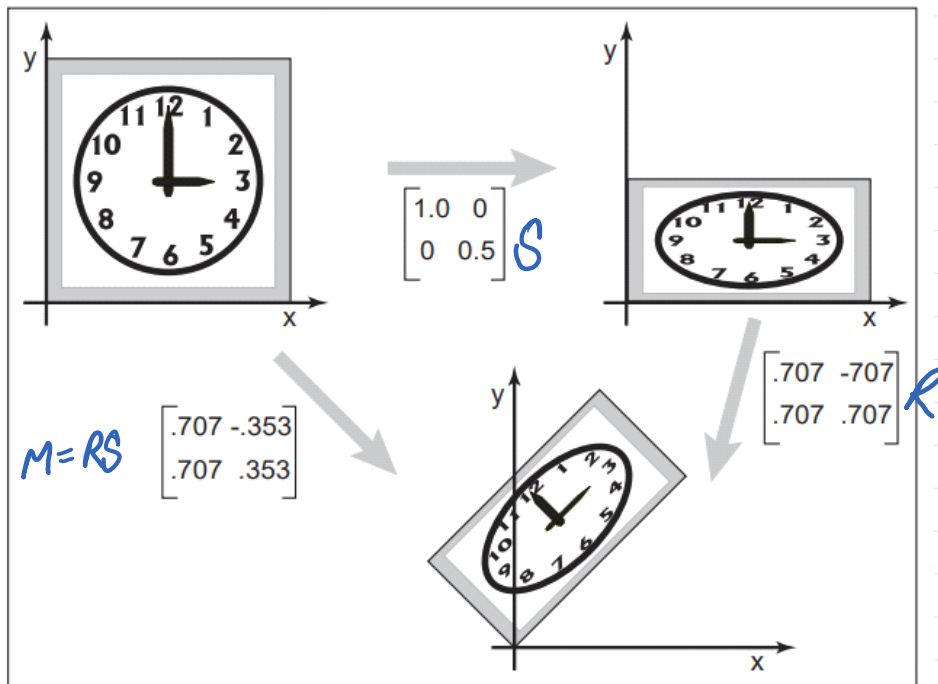
$$\boxed{v_3 = (RS)v_1}$$

$$\Rightarrow \underbrace{M}_{RS} = RS$$

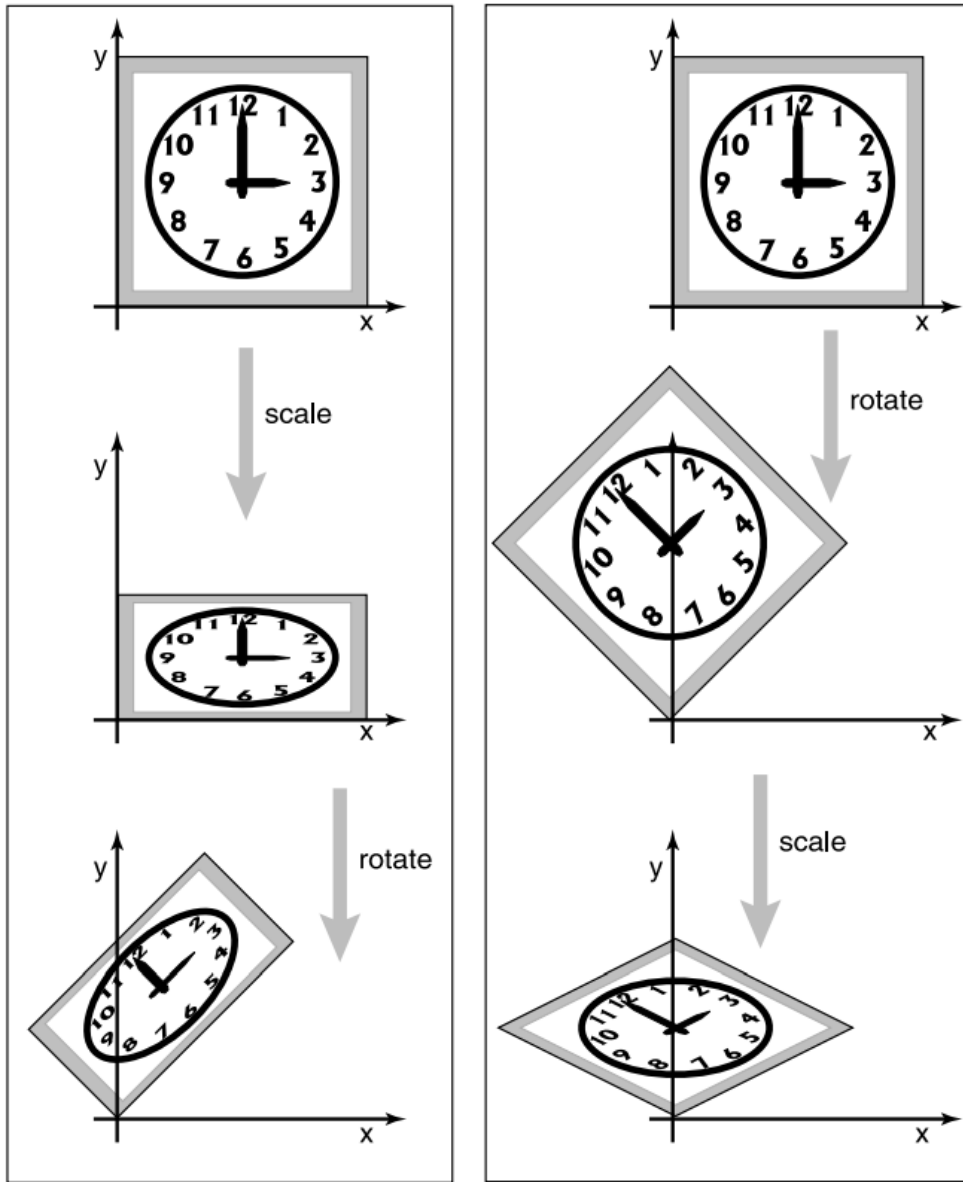
in terms of single matrix.

$$R = \begin{bmatrix} 1 & 0 \\ 0 & 0.5 \end{bmatrix}_{2 \times 2} \quad S = \begin{bmatrix} \cos 45^\circ & -\sin 45^\circ \\ \sin 45^\circ & \cos 45^\circ \end{bmatrix}_{2 \times 2}$$

$$M = RS = \begin{bmatrix} \quad & \quad \\ \quad & \quad \end{bmatrix}_{2 \times 2}$$



$$RS = SR ?$$



“Any linear transformation can be thought of as a combination of rotation and scaling.”