



we want to rotate point  $(x_4, y_4)$  around arbitrary point  $(x_3, y_3)$  in anticlockwise direction by angle of  $60^\circ$

Combined Transform<sup>n</sup> matrix = 
$$\begin{bmatrix} 1 & 0 & -x_3 \\ 0 & 1 & -y_3 \\ 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} 1 & 0 & x_3 \\ 0 & 1 & y_3 \\ 0 & 0 & 1 \end{bmatrix}$$

Therefore

multiply in this direction

multiplication in reverse direction

$$= \begin{bmatrix} 1 & 0 & x_3 \\ 0 & 1 & y_3 \\ 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} 1 & 0 & -x_3 \\ 0 & 1 & -y_3 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} \cos\theta & \sin\theta & x_3 \\ -\sin\theta & \cos\theta & y_3 \\ 0 & 0 & 1 \end{bmatrix} * \begin{bmatrix} 1 & 0 & -x_3 \\ 0 & 1 & -y_3 \\ 0 & 0 & 1 \end{bmatrix}$$

Combined Transform<sup>n</sup> matrix = 
$$\begin{bmatrix} \cos\theta & \sin\theta & -x_3\cos\theta - y_3\sin\theta + x_3 \\ -\sin\theta & \cos\theta & x_3\sin\theta - y_3\cos\theta + y_3 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x_4' \\ y_4' \\ 1 \end{bmatrix} = \begin{bmatrix} \text{Combined} \\ \text{Transform}^n \\ \text{matrix} \end{bmatrix} * \begin{bmatrix} x_4 \\ y_4 \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} x_4\cos\theta + y_4\sin\theta - x_3\cos\theta - y_3\sin\theta + x_3 \\ -x_4\sin\theta + y_4\cos\theta + x_3\sin\theta - y_3\cos\theta + y_3 \\ 1 \end{bmatrix}$$