Step-1

A reflection matrix transforms every vector into its image on the opposite side of mirror.

Let $S=\begin{bmatrix}0 & 1\\ 1 & 0\end{bmatrix}$ be the reflection matrix that transforms (x,y) to (y,x).

$\det S = 0-1=-1$

Let $T=\begin{bmatrix}-1 & 0\\ 0 & 1\end{bmatrix}$ be the reflection matrix that transforms (x,y) to $(-x,y)$.

$\det T = -1-0=-1$

Consider product of matrices,

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

$\det ST = 0-(-1)=1$

Therefore, the product ST is a rotation.

Step-2

Consider the product of reflections,

$$\begin{bmatrix}\cos 2\theta & \sin 2\theta\\ \sin 2\theta & -\cos 2\theta\end{bmatrix}\begin{bmatrix}\cos 2\alpha & \sin 2\alpha\\ \sin 2\alpha & -\cos 2\alpha\end{bmatrix}$$

$$=\begin{bmatrix}\cos 2\theta\cos 2\alpha+\sin 2\theta\sin 2\alpha & \cos 2\theta\sin 2\alpha-\cos 2\alpha\sin 2\theta\\ \sin 2\theta\cos 2\alpha-\cos 2\theta\sin 2\alpha & \sin 2\theta\sin 2\alpha+\cos 2\theta\cos 2\alpha\end{bmatrix}$$

$$=\begin{bmatrix}\cos 2(\theta-\alpha) & \sin(2(\alpha-\theta))\\ \sin 2(\theta-\alpha) & \cos(2(\theta-\alpha))\end{bmatrix}$$

$$=\begin{bmatrix}\cos 2(\theta-\alpha) & -\sin(2(\theta-\alpha))\\ \sin 2(\theta-\alpha) & \cos 2(\theta-\alpha)\end{bmatrix}$$

Hence the angle of rotation is $\boxed{2(\theta-\alpha)}$.