Step-1

(a)

To find the first column of 3×3 matrix, consider the following vector:

$$\begin{bmatrix}1\\0\\0\end{bmatrix}$$

Project the vector $\begin{bmatrix}1\\0\\0\end{bmatrix}$ onto *x*-*y* plane, and get the vector $\begin{bmatrix}1\\0\\0\end{bmatrix}$.

Step-2

To find the second and third column of 3×3 matrix, consider the following vectors:

$\begin{bmatrix}0\\1\\0\end{bmatrix}$ And $\begin{bmatrix}0\\0\\1\end{bmatrix}$

Project the vector $\begin{bmatrix}0\\1\\0\end{bmatrix}$ onto *x*-*y* plane, and get the vector $\begin{bmatrix}0\\1\\0\end{bmatrix}$.

Now, project the vector $\begin{bmatrix}0\\0\\1\end{bmatrix}$ onto *x*-*y* plane, and get the vector $\begin{bmatrix}0\\0\\0\end{bmatrix}$.

Step-3

Therefore, the matrix transformation by projecting every vector onto the *x*-*y* plane is given by $\boxed{\begin{bmatrix}1&0&0\\0&1&0\\0&0&0\end{bmatrix}}$.

Step-4

(b)

To find the first column of 3×3 matrix, consider the following vector:

$$\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$$

Reflect the vector $\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$ through the *x*-*y* plane, we get the vector $\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$.

Step-5

To find the second and third column of 3×3 matrix, consider the following vectors:

$\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$ And $\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$

Reflect the vector $\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$ through the $xy-$ plane, and get the vector $\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$.

Now, reflect the vector $\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$ through the xy-plane, and get the vector $\begin{bmatrix} 0 \\ 0 \\ -1 \end{bmatrix}$.

Step-6

Therefore, the matrix of transformation by reflecting every vector though the *x*-*y* plane is given by $\boxed{\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{bmatrix}}$.

Step-7

(c)

To find the first column of 3×3 matrix, consider the following vector:

$$\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$$

Rotate the vector $\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$ in the *x*-*y* plane by 90°, and get the vector $\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$.

To find the second and third column of 3×3 matrix, consider the following vectors:

$\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$ And $\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$

Rotate the vector $\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$ in the *x*-*y* plane by 90°, and get vector $\begin{bmatrix} -1 \\ 0 \\ 0 \end{bmatrix}$.

Rotate the vector $\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$ in the *x*-*y* plane by 90°, and get the vector $\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$.

Step-8

Therefore, the matrix of transformation by rotating the *x*-*y* plane through 90°, leaving the *z*-axis alone is given by $\boxed{\begin{bmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}}$.

Step-9

(d)

To find the first column of 3×3 matrix, consider the following vector:

$$\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$$

Rotate the vector $\begin{bmatrix}1\\0\\0\end{bmatrix}$ in the *x*-*y* plane by 90°, and get vector $\begin{bmatrix}0\\1\\0\end{bmatrix}$.

Rotate the vector $\begin{bmatrix}0\\1\\0\end{bmatrix}$ in *x*-*z* plane by 90°, and get vector $\begin{bmatrix}0\\1\\0\end{bmatrix}$.

Rotate the vector $\begin{bmatrix}0\\1\\0\end{bmatrix}$ in *y*-*z* plane by 90°, we get vector $\begin{bmatrix}0\\0\\1\end{bmatrix}$.

Step-10

To find the second column of 3×3 matrix, consider the following vectors:

$$\begin{bmatrix}0\\1\\0\end{bmatrix}$$

Rotate the vector $\begin{bmatrix}0\\1\\0\end{bmatrix}$ in the *x*-*y* plane by 90°, and get vector $\begin{bmatrix}0\\-1\\0\end{bmatrix}$.

Rotate the vector $\begin{bmatrix}0\\-1\\0\end{bmatrix}$ in *x*-*z* plane by 90°, and get vector $\begin{bmatrix}0\\0\\-1\end{bmatrix}$.

Rotate the vector $\begin{bmatrix}0\\0\\-1\end{bmatrix}$ in *y*-*z* plane by 90°, and get vector $\begin{bmatrix}0\\1\\0\end{bmatrix}$.

Step-11

To find the third column of 3×3 matrix, consider the following vector:

$$\begin{bmatrix}0\\0\\1\end{bmatrix}$$

Rotate the vector $\begin{bmatrix}0\\0\\1\end{bmatrix}$ in the *x-y* plane by $90°$, and get vector $\begin{bmatrix}0\\0\\1\end{bmatrix}$.

Rotate the vector $\begin{bmatrix}0\\0\\1\end{bmatrix}$ in *x-z* plane by $90°$, and get vector $\begin{bmatrix}-1\\0\\0\end{bmatrix}$.

Rotate the vector $\begin{bmatrix}-1\\0\\0\end{bmatrix}$ in *y-z* plane by $90°$, and get vector $\begin{bmatrix}-1\\0\\0\end{bmatrix}$.

Therefore, the matrix transformation by rotating the *x-y* plane, then *x-z* plane and then *y-z* through $90°$, is given by $\boxed{\begin{bmatrix}0 & 0 & -1\\0 & 1 & 0\\1 & 0 & 0\end{bmatrix}}$.

Step-12

(e)

To find the first column of 3×3 matrix, consider the following vector:

$$\begin{bmatrix}1\\0\\0\end{bmatrix}$$

Step-13

Rotate the vector $\begin{bmatrix}1\\0\\0\end{bmatrix}$ in the *x-y* plane by $180°$, and get vector $\begin{bmatrix}-1\\0\\0\end{bmatrix}$.

Rotate the vector $\begin{bmatrix}-1\\0\\0\end{bmatrix}$ in *x-z* plane by $180°$, and get vector $\begin{bmatrix}1\\0\\0\end{bmatrix}$.

Rotate the vector $\begin{bmatrix}1\\0\\0\end{bmatrix}$ in *y-z* plane by $180°$, and get vector $\begin{bmatrix}1\\0\\0\end{bmatrix}$.

Step-14

To find the second column of 3×3 matrix, consider the following vector:

$$\begin{bmatrix}0\\1\\0\end{bmatrix}$$

Rotate the vector $\begin{bmatrix}0\\1\\0\end{bmatrix}$ in the *x*-*y* plane by $180°$, and get vector $\begin{bmatrix}0\\-1\\0\end{bmatrix}$.

Rotate the vector $\begin{bmatrix}0\\-1\\0\end{bmatrix}$ in *x*-*z* plane by $180°$, and get vector $\begin{bmatrix}0\\-1\\0\end{bmatrix}$.

Rotate the vector $\begin{bmatrix}0\\-1\\0\end{bmatrix}$ in *y*-*z* plane by $180°$, and get vector $\begin{bmatrix}0\\1\\0\end{bmatrix}$.

Step-15

To find the third column of 3×3 matrix, consider the following vector:

$$\begin{bmatrix}0\\0\\1\end{bmatrix}$$

Rotate the vector $\begin{bmatrix}0\\0\\1\end{bmatrix}$ in the *x*-*y* plane by $180°$, and get vector $\begin{bmatrix}0\\0\\1\end{bmatrix}$.

Rotate the vector $\begin{bmatrix}0\\0\\1\end{bmatrix}$ in *x*-*z* plane by $180°$, and get vector $\begin{bmatrix}0\\0\\-1\end{bmatrix}$.

Rotate the vector $\begin{bmatrix}0\\0\\-1\end{bmatrix}$ in *y*-*z* plane by $180°$, and get vector $\begin{bmatrix}0\\0\\1\end{bmatrix}$.

Step-16

Therefore, the matrix of transformation by rotating the *x-y* plane, then *x-z* plane and then *y-z* by $180°$, is given by $\boxed{\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}}$.