

Matgeo-4.8.35

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Question

Q.4.8.35 Find the coordinates of the foot of the perpendicular drawn from the point $\begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix}$ on the x -axis

Solution. Let the x -axis be represented as the intersection of the two planes

$$\mathbf{e}_2^T \mathbf{x} = 0, \quad \mathbf{e}_3^T \mathbf{x} = 0,$$

where

$$\mathbf{e}_1 = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}, \quad \mathbf{e}_2 = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}, \quad \mathbf{e}_3 = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}.$$

The direction vector of the x -axis is $\mathbf{m} = \mathbf{e}_1$ and the given point is

$$\mathbf{P} = \begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix}.$$

By the foot-of-perpendicular relation,

$$(\mathbf{m} \quad \mathbf{e}_2 \quad \mathbf{e}_3)^T \mathbf{Q} = \begin{pmatrix} \mathbf{m}^T \mathbf{P} \\ 0 \\ 0 \end{pmatrix}. \quad (1)$$

Solution

Substituting $\mathbf{m} = \mathbf{e}_1$ and $\mathbf{P} = \begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix}$,

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \mathbf{Q} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} \implies \mathbf{Q} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}. \quad (2)$$

Thus, the foot of the perpendicular from $\begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix}$ to the x -axis is

$$\boxed{\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}}.$$

Plot

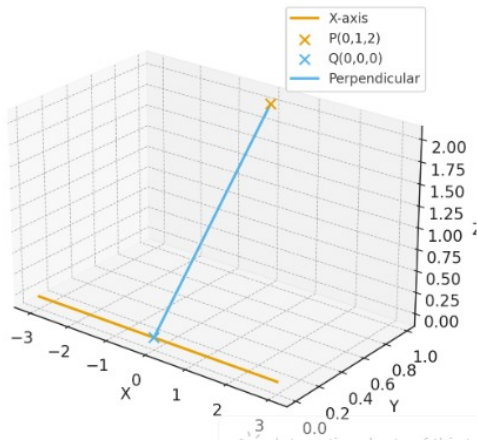


Figure: Perpendicular from $\mathbf{P} = \begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix}$ to the x -axis with foot $\mathbf{Q} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$.