Step-1

Let $a_1 = \begin{pmatrix} 1 \\ 0 \end{pmatrix}, a_1 = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$

Writing $A = \begin{bmatrix} a_1 & a_2 \end{bmatrix}$

$= \begin{bmatrix} 1 & 1 \\ 0 & 2 \end{bmatrix}$, the required projection matrix is $P = A\left(A^T A\right)^{-1} A^T$

$A^T A = \begin{bmatrix} 1 & 0 \\ 1 & 2 \end{bmatrix}\begin{bmatrix} 1 & 1 \\ 0 & 2 \end{bmatrix}$

$\quad = \begin{bmatrix} 1 & 1 \\ 1 & 5 \end{bmatrix}$

$\left(A^T A\right)^{-1} = \frac{1}{4}\begin{bmatrix} 5 & -1 \\ -1 & 1 \end{bmatrix}$

Step-2

$A\left(A^T A\right)^{-1} = \frac{1}{4}\begin{bmatrix} 1 & 1 \\ 0 & 2 \end{bmatrix}\begin{bmatrix} 5 & -1 \\ -1 & 1 \end{bmatrix}$

$\quad = \frac{1}{4}\begin{bmatrix} 4 & 0 \\ -2 & 2 \end{bmatrix}$

$A\left(A^T A\right)^{-1} A^T = \frac{1}{4}\begin{bmatrix} 4 & 0 \\ -2 & 2 \end{bmatrix}\begin{bmatrix} 1 & 0 \\ 1 & 2 \end{bmatrix}$

$\quad = \frac{1}{4}\begin{bmatrix} 4 & 0 \\ 0 & 4 \end{bmatrix}$

Therefore, $P = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$