

Step-1

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$$x^T Ay = [0 \ 1] \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$$

(a) Given that

We have to verify that the row vector x^T times A times the column vector y produces what number.

Step-2

Now

$$\begin{aligned} x^T Ay &= [0 \ 1] \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} \\ &= [0 \ 1] \begin{bmatrix} 1(0)+2(1)+3(0) \\ 4(0)+5(1)+6(0) \end{bmatrix} \\ &= [0 \ 1] \begin{bmatrix} 0+2+0 \\ 0+5+0 \end{bmatrix} \\ &= [0 \ 1] \begin{bmatrix} 2 \\ 5 \end{bmatrix} \\ &= [0(2)+1(5)] \\ &= [5] \end{aligned}$$

Hence $\boxed{x^T Ay = [5]}$

Step-3

(b) Now

$$\begin{aligned} x^T A &= [0 \ 1] \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix} \\ &= [0(1)+1(4) \quad 0(2)+1(5) \quad 0(3)+1(6)] \\ &= [4 \ 5 \ 6] \end{aligned}$$

Therefore, $\boxed{[4 \ 5 \ 6]}$ is the row that is $x^T A$ times the column $y = (0, 1, 0)$.

Step-4

(c) Now

$$\begin{aligned} Ay &= \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 2 \\ 5 \end{bmatrix} \\ &= \begin{bmatrix} 1(0) + 2(1) + 3(0) \\ 4(0) + 5(1) + 6(0) \end{bmatrix} \\ &= \begin{bmatrix} 0 + 2 + 0 \\ 0 + 5 + 0 \end{bmatrix} \\ &= \begin{bmatrix} 2 \\ 5 \end{bmatrix} \end{aligned}$$

Therefore, the row x^T times the column Ay is $\boxed{\boxed{\begin{bmatrix} 2 \\ 5 \end{bmatrix}}}$.