12.873

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Question

Consider a Cartesian coordinate system defined over a 3-dimensional vector space with orthogonal unit basis vectors $\hat{i}$ $\hat{j}$ and $\hat{k}$. Let vector $\mathbf{a} = \sqrt{2}\hat{i} + \frac{1}{\sqrt{2}}\hat{j} + \hat{k}$ and vector $\mathbf{b} = \frac{1}{\sqrt{2}}\hat{i} + \sqrt{2}\hat{j} - \hat{k}$. The inner product of these vectors $(\mathbf{a}.\mathbf{b})$ is

The given vectors can be given as:

$$\mathbf{a} = \begin{pmatrix} \sqrt{2} \\ \frac{1}{\sqrt{2}} \\ 1 \end{pmatrix} \tag{1}$$

$$\mathbf{b} = \begin{pmatrix} \frac{1}{\sqrt{2}} \\ \sqrt{2} \\ -1 \end{pmatrix} \tag{2}$$

And also

$$\mathbf{a}.\mathbf{b} = \mathbf{a}^T\mathbf{b} \tag{3}$$

Theoretical Solution

$$\mathbf{a}^T\mathbf{b} = \begin{pmatrix} \sqrt{2} \\ \frac{1}{\sqrt{2}} \\ 1 \end{pmatrix}^T \begin{pmatrix} \frac{1}{\sqrt{2}} \\ \sqrt{2} \\ -1 \end{pmatrix} \tag{4}$$

$$\mathbf{a}^T\mathbf{b} = 1 + 1 - 1 \tag{5}$$

$$\mathbf{a}^T\mathbf{b} = 1 \tag{6}$$

$$\mathbf{a}.\mathbf{b} = 1 \tag{7}$$