Diagonalizing Matrices

1) If $B \doteq \begin{pmatrix} 4 & 0 \\ 0 & 2 \end{pmatrix}$, calculate $\langle 1|B|1 \rangle$, $\langle 1|B|2 \rangle$, $\langle 2|B|1 \rangle$ and $\langle 2|B|2 \rangle$.

2) If $C \doteq \begin{pmatrix} 3 & 1 \\ 1 & 3 \end{pmatrix}$, show that the vectors $|\alpha\rangle \doteq \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ 1 \end{pmatrix}$ and $|\beta\rangle \doteq \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ -1 \end{pmatrix}$ are eigenvectors of C and find the eigenvalues.

3) Show that $|\alpha\rangle$ and $|\beta\rangle$ are orthonormal.

4) Calculate $\langle \alpha|C|\alpha \rangle$, $\langle \alpha|C|\beta \rangle$, $\langle \beta|C|\alpha \rangle$ and $\langle \beta|C|\beta \rangle$.

5) How are B and C related?

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