1 | Exercise 7

Suppose $T \in \mathcal{L}(V)$ has a diagonal matrix A with respect to some basis of V and that $\lambda \in \mathbb{F}$. Prove that λ appears on the diagonal of A precisely dim $E(\lambda, T)$ times.

2 | Proof

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There must be $\odim V$ (non-distinct) eigenvalues on the diagonal.
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Any eigenvalue λ must have dim $E(\lambda, T)$ associated eigenvectors, by definition. ("In other words, $E(\lambda, T)$ is the set of all eigenvectors of T corresponding to λ, along with the 0 vector").

λ appears exactly once for each associated eigenvalue. The diagonal is comprised of the basis vector coefficients of the eigenspaces, implying that each eigenspace of λ is represented by dim $E(\lambda, T)$ eigenvectors.