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Theorem a $\quad f_a : \mathbb{R}^2 \to \mathbb{R}^2 \quad f_a(v) = av$

New basis $\{v, w\}$. Then the matrix $\tilde{a}$ of f_a with respect to the new basis is given by

$$\tilde{a} = c^{-1} a c$$

Where $c = (v, w)$ is the unique matrix such that $c\begin{pmatrix}1\\0\end{pmatrix} = v$ $\quad c\begin{pmatrix}0\\1\end{pmatrix} = w$.

Proof the matrix of $\tilde{a}$

$$f_a(v) = \lambda v + \mu w \qquad \tilde{a} = \begin{bmatrix} \lambda & \gamma \\ \mu & \delta \end{bmatrix}$$

$$f_a(w) = \gamma v + \delta w$$

Recall 1) $f_a(v) = av$ $\qquad$ 2) $c^{-1}av = \begin{pmatrix}\lambda\\\mu\end{pmatrix}$

$$c^{-1}aw = \begin{pmatrix}\gamma\\\delta\end{pmatrix}$$

$$c^{-1}a\overbrace{(v \;\; w)}^{c} = c^{-1}ac\begin{pmatrix}1 & 0\\0 & 1\end{pmatrix} \qquad \text{bc } \; c\begin{pmatrix}1\\0\end{pmatrix} = v, \; c\begin{pmatrix}0\\1\end{pmatrix} = w$$

$$\begin{pmatrix}\lambda & \gamma\\ \mu & \delta\end{pmatrix} = c^{-1}ac$$

$\boxed{\Xi}$

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