2. $W = \{(x,y) \in \mathbb{R}^2 : x+y=0\}$.

(ii) $\langle (x_1,y_1),(x_2,y_2)\rangle = 2x_1x_2 + y_1y_2$

Let $(a,b) \in \mathbb{R}^2$. The shortest distance from (a,b) to W is $\| (a,b) - \text{proj}_W (a,b) \|$.

An orthonormal basis for W is $\mathcal{B} = \{ (\frac{1}{\sqrt{3}}, \frac{-1}{\sqrt{3}}) \}$

Since $\langle (\frac{1}{\sqrt{3}}, \frac{-1}{\sqrt{3}}), (\frac{1}{\sqrt{3}}, \frac{-1}{\sqrt{3}}) \rangle = \frac{2}{3} + \frac{1}{3} = 1$

and $(\frac{1}{\sqrt{3}}, \frac{-1}{\sqrt{3}}) \in W$, and $\dim W = 1$.

Now, $\text{proj}_W (a,b) = \langle (a,b), (\frac{1}{\sqrt{3}}, \frac{-1}{\sqrt{3}}) \rangle (\frac{1}{\sqrt{3}}, \frac{-1}{\sqrt{3}})$

$$= \frac{2a-b}{\sqrt{3}} \left(\frac{1}{\sqrt{3}}, \frac{-1}{\sqrt{3}}\right)$$

$$\| (a,b) - \text{proj}_W (a,b) \| = \left\| (a,b) - \left(\frac{2a-b}{3}, \frac{-2a+b}{3}\right) \right\|$$

$$= \left\| \left(\frac{a+b}{3}, \frac{2a+2b}{3}\right) \right\|$$

$$= \left\langle \left(\frac{a+b}{3}, \frac{2a+2b}{3}\right), \left(\frac{a+b}{3}, \frac{2a+2b}{3}\right) \right\rangle^{1/2}$$

$$= \left\langle (a+b)\left(\frac{1}{3}, \frac{2}{3}\right), (a+b)\left(\frac{1}{3}, \frac{2}{3}\right) \right\rangle^{1/2}$$

$$= (a+b) \left\langle \left(\frac{1}{3}, \frac{2}{3}\right), \left(\frac{1}{3}, \frac{2}{3}\right) \right\rangle^{1/2}$$

$$= (a+b) \left(\frac{2}{9} + \frac{4}{9}\right)^{1/2}$$

$$= (a+b) \frac{\sqrt{6}}{3}$$