2.45 An elliptically polarized wave traveling in the negative z-direction is received by a circularly polarized antenna whose main lobe is along the $\theta = 0$ direction. The unit vector describing the polarization of the incident wave is given by

$$\hat{\rho}_w = \frac{2\hat{\mathbf{a}}_x + j\hat{\mathbf{a}}_y}{\sqrt{5}}$$

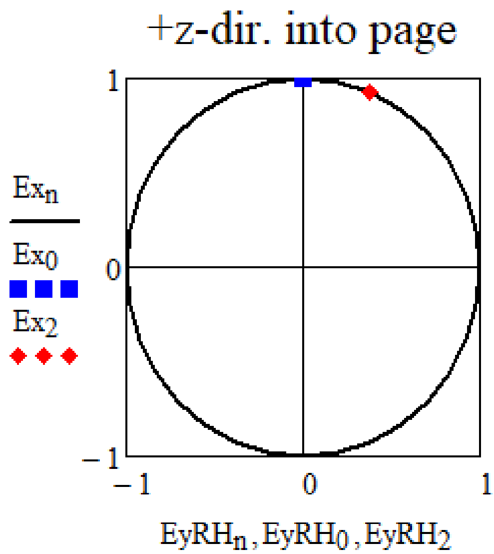
Find the polarization loss factor PLF (*dimensionless* and *in dB*) when the wave that would be transmitted by the antenna is

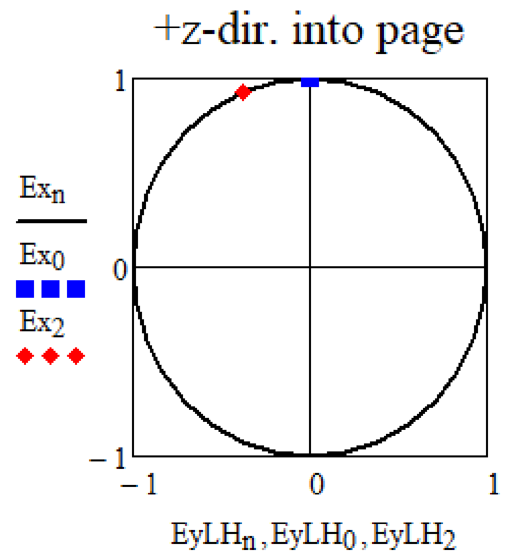
(a) right-hand CP (b) left-hand CP

A circularly-polarized antenna with a main beam at $\theta = 0$ will radiate/transmit in the $+z$-direction at the $z = 0$ plane. Let $E_x = E_y = 1$ V/m.

$$n := 0..32 \qquad wt_n := n\frac{\pi}{16} \qquad Ex_n := 1\cos(wt_n)$$

$$EyRH_n := 1\cdot\cos(wt_n - 0.5\pi) \qquad EyLH_n := 1\cdot\cos(wt_n + 0.5\pi)$$





a) RH CP antenna ($z=0$)

$$\bar{E}_{RH} = \hat{a}_x 1 + \hat{a}_y 1\angle{-\pi/2}$$

$$\hat{\rho}_{a,RH} = \frac{1}{\sqrt{2}}(\hat{a}_x - j\hat{a}_y)$$

b) LH CP antenna @ $z=0$

$$\bar{E}_{LH} = \hat{a}_x 1 + \hat{a}_y 1\angle{+\pi/2}$$

$$\hat{\rho}_{a,LH} = \frac{1}{\sqrt{2}}(\hat{a}_x + j\hat{a}_y)$$

Per (2-71), $PLF = |\hat{\rho}_w \cdot \hat{\rho}_a|^2$

a) $$PLF = \left|\left(\frac{2\hat{a}_x + j\hat{a}_y}{\sqrt{5}}\right)\cdot\left(\frac{\hat{a}_x - j\hat{a}_y}{\sqrt{2}}\right)\right|^2 = \left|\frac{2+1}{\sqrt{2}\sqrt{5}}\right|^2$$

$$= 0.9 = 10\log_{10} 0.9 = -0.4576 \text{ dB}$$

b) $$PLF = \left|\left(\frac{2\hat{a}_x + j\hat{a}_y}{\sqrt{5}}\right)\cdot\left(\frac{\hat{a}_x + j\hat{a}_y}{\sqrt{2}}\right)\right|^2 = \left|\frac{2-1}{\sqrt{2}\sqrt{5}}\right|^2$$

$$= 0.1 = 10\log_{10} 0.1 = -10 \text{ dB}$$