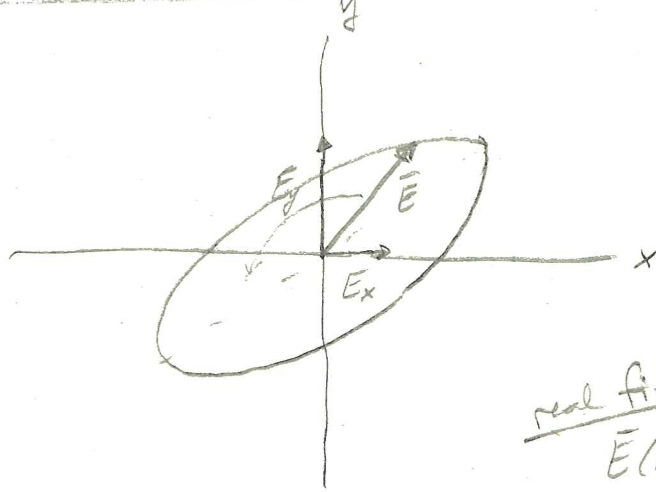
Polarization Visualization

Tues. 3/1/16



real field:

$$\bar{E}(z=0,t) = E_x(z=0,t)\hat{x} + E_y(z=0,t)\hat{y}$$

Slider 1: $\psi \in [0°, 90°]$

$\delta \in (-\pi, \pi]$

Slider 2: or $a \in (-1, 1]$ & write as $\delta = a\pi$

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phasor:

$$\bar{E} = \left(\hat{x} E_{x0} + \hat{y} E_{y0} e^{j\delta}\right) e^{-jkz}$$

real

or $$\bar{E} = \left(\hat{x} E_{x0} e^{j\delta_x} + \hat{y} E_{y0} e^{j\delta_y}\right) e^{-jkz}$$

$$= E_{x0} e^{j\delta_x} \left(\hat{x} + \hat{y} \frac{E_{y0}}{E_{x0}} e^{j(\delta_y - \delta_x)}\right) e^{-jkz}$$

let $\tan\psi = \frac{E_{y0}}{E_{x0}}$ with $\psi \in [0, \pi/2]$

and $\delta = \delta_y - \delta_x$ with $\delta \in (-\pi, \pi]$

Then

$$\bar{E} = E_{x0} e^{j\delta_x} \left(\hat{x} + \hat{y} \tan\psi e^{j\delta}\right) e^{-jkz}$$

Real electric field:

$$\bar{\mathcal{E}}(z,t) = \mathrm{Re}\left\{\bar{E} e^{j\omega t}\right\}$$

$$= \mathrm{Re}\left\{ E_{xo}\left(\hat{x} e^{j(\omega t - kz + \delta_x)} + \hat{y} \tan\psi\, e^{j(\omega t - kz + \delta_x + \delta)} \right) \right\}$$

$$= \hat{x} E_{xo} \cos(\omega t - kz + \delta_x) + \hat{y} E_{xo} \tan\psi \cos(\omega t - kz + \delta_x + \delta) \}$$

Let $\delta_x = 0$, $E_{xo} = 1$ and look in the $z = 0$ plane:

$$\boxed{\mathcal{E}(0,t) = \hat{x}\cos(\omega t) + \hat{y} \tan\psi \cos(\omega t + \delta)}$$

Let let $t_{norm} = ft$ such that

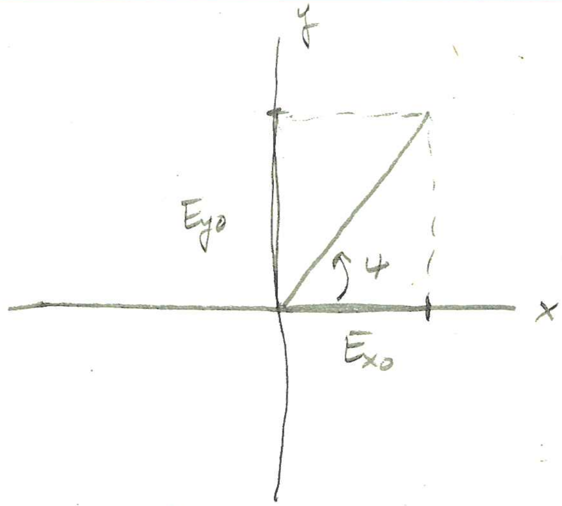
$$\omega t = 2\pi t_{norm}$$

Also let $t_{norm} \in [0, 1)$ such that $\omega t \in [0, 2\pi)$

Then $x = \cos(2\pi t_{norm})$

$y = \tan\psi \cos(2\pi t_{norm} + \delta)$

but, $\tan\psi \in [0, \infty]$!!



let $A = \sqrt{E_{xo}^2 + E_{yo}^2}$

then $E_{xo} = A \cos\psi$

$E_{yo} = A \sin\psi$

so,

$$\bar{\mathcal{E}}(z,t) = \hat{x} A \cos\psi \cos(\omega t - kz + \delta_x) + \hat{y} A \sin\psi \cos(\omega t - kz + \delta_x + \delta)$$

let $A = 0$, $\delta_x = 0$, $z = 0$:

$$\bar{\mathcal{E}}(0,t) = \hat{x} \cos\psi \cos(\omega t) + \hat{y} \sin\psi \cos(\omega t + \delta)$$