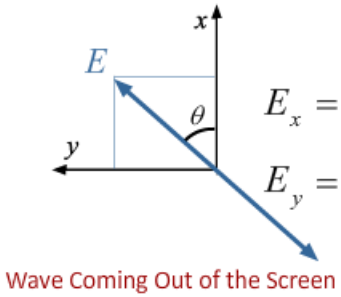
Circularly Polarized Light

There is no reason that ϕ has to be the same for E_x and E_y:



$$E_x = E_o \cos\theta \sin(kz - \omega t + \phi_x)$$
$$E_y = E_o \sin\theta \sin(kz - \omega t + \phi_y)$$

Satisfies Wave Equation

$$\frac{\partial^2 E_x}{\partial z^2} = \mu_o \varepsilon_o \frac{\partial^2 E_x}{\partial t^2}$$
$$\frac{\partial^2 E_y}{\partial z^2} = \mu_o \varepsilon_o \frac{\partial^2 E_y}{\partial t^2}$$

Making ϕ_x different from ϕ_y causes circular or elliptical polarization:

Example:

$$\phi_x - \phi_y = 90^\circ = \frac{\pi}{2}$$
$$\theta = 45^\circ = \pi/4$$

$$E_x = \frac{E_0}{\sqrt{2}} \cos(kz - \omega t)$$
$$E_y = \frac{E_0}{\sqrt{2}} \sin(kz - \omega t)$$