Exercise:

$$\bar{E}(x) = (\bar{a}_z - j\bar{a}_y)\, E_0\, e^{jkx} \qquad E_0 \in \mathbb{R}$$

RCP or LCP ?

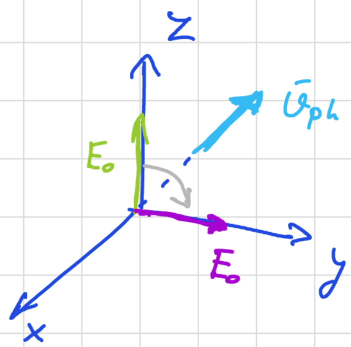
Solution

$$\bar{E}(x,t) = E_0 \; Re\left[e^{j(\omega t + kx)} (\bar{a}_z - j\bar{a}_y) \right]$$

$$= E_0 \left[\bar{a}_z \cos(\omega t + kx) + \bar{a}_y \sin(\omega t + kx) \right]$$

$$\omega t + kx = const$$

$$\omega + k \frac{dx}{dt} = 0 \rightarrow v_{ph,x} = -\frac{\omega}{k}$$



$x=0;\ \omega t = 0 \rightarrow \bar{E}(0,0) = \bar{a}_z$

$x=0;\ \omega t = \frac{\pi}{2} \rightarrow \bar{E}(0, T/4) = \bar{a}_y$

RCP !

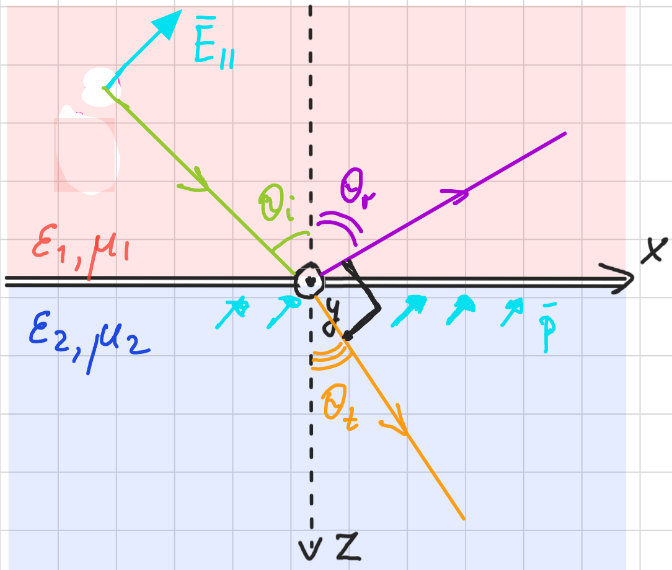
Exercise:

How is the H-field rotates for such wave?

RCP or linear or LCP ?

About Brewster's angle

$$\Gamma_{\parallel} = \frac{E_{r0}}{E_{i0}} = \frac{\eta_2 \cos\theta_t - \eta_1 \cos\theta_i}{\eta_2 \cos\theta_t + \eta_1 \cos\theta_i}$$



$\Gamma_{\parallel} = 0$ when

$$\eta_2 \cos\theta_t = \eta_1 \cos\theta_i \quad (1)$$

$\mu_1 = \mu_2 = \mu_0 \qquad \varepsilon_1 = \varepsilon_0$

$\eta_1 = \eta_0 \eta_{1r}$

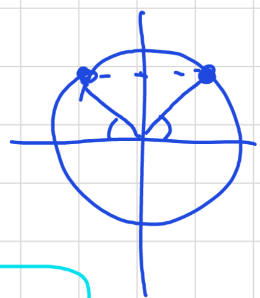
$\eta_{1r} = \frac{1}{n_1} = 1 \qquad \eta_{2r} = \frac{1}{n_2} = \frac{1}{n}$

(1) : $\cos\theta_t = n \cos\theta_i \quad (2)$

From Snell's law: $\frac{\sin\theta_i}{\sin\theta_t} = n \quad (3)$

$$\frac{\cos\theta_t}{\cos\theta_i} = \frac{\sin\theta_i}{\sin\theta_t}$$

$$\sin 2\theta_t = \sin 2\theta_i$$



$$\begin{cases} \cancel{2}\theta_t = \cancel{2}\theta_i & \text{trivial} \\ 2\theta_t = \pi - 2\theta_i \rightarrow & \boxed{\theta_t + \theta_i = \pi/2} \end{cases}$$

(2): $\cos\theta_t = \sin\theta_i = n\cos\theta_i \Rightarrow \quad \theta_i = \arctan(n)$

Exercise Session 6

Problem:

Let us compare the efficiency of two communication channels over a distance d: a coaxial cable and a free-space wireless radio connection at frequency of 3 GHz. Assume that the attenuation of the coaxial cable is 20 dB/km and that for the radio communication channel we use transmitting and receiving antennas which both have a gain of 20 dB.

a) Calculate the attenuation at 1 km and 10 km for both coaxial cable and radio wave. What do you find?

b) What is the dependence of the attenuation on distance for these two channels?

c) Find the threshold distance at which attenuation from coaxial and radio wave channels is the same.

$$P_{rec} = \left(\frac{\lambda}{4\pi R}\right)^2 G_{max}^{(tr)} G_{max}^{(rec)} P_{inp}$$ ← Friis transmission formula

Decibel

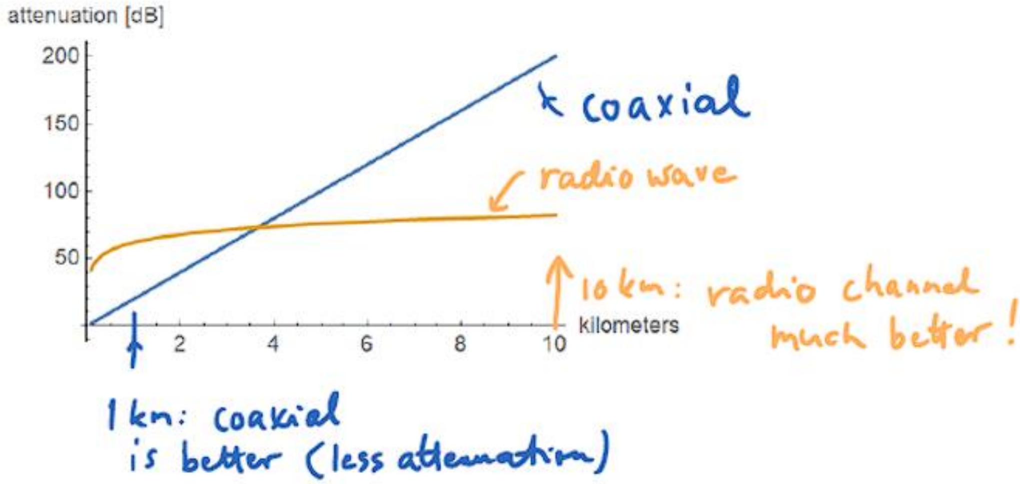
10^{12}

	Linear	→	Logarithmic (Bels)	dB
	10 : 1		1 bel	10
	100 : 1		2 bel	20
	1000.000 : 1		6 bel	60
	⋮		⋮	⋮

Bel = $\log_{10}(P/P_{ref})$ (P/P_ref: power ratio)

1 dB = 0,1 Bel   (1 dm) = 0,1 m

$dB = 10 \log_{10}(P/P_{ref})$ ← power ratios


attenuation [dB]
200
150
100
50
2
4
6
8
10
kilometers
coaxial
radio wave
10 km: radio channel much better!
1 km: coaxial is better (less attenuation)