

Problem P2.3

Consider an electromagnetic wave propagating in the \hat{z} -direction with

$$\overline{E} = \hat{x}e_x \cos(kz - \omega t + \psi_x) + \hat{y}e_y \cos(kz - \omega t + \psi_y)$$

where e_x , e_y , ψ_x , and ψ_y are all real numbers.

- Let $e_x = 2$, $e_y = 1$, $\psi_x = \pi/2$, $\psi_y = \pi/4$. What is the polarization?
- Let $e_x = 1$, $e_y = \psi_x = 0$. This is a linearly polarized wave. Prove that it can be expressed as the superposition of a right-hand circularly polarized wave and a left-hand circularly polarized wave.
- Let $e_x = 1$, $\psi_x = \pi/4$, $\psi_y = -\pi/4$, $e_y = 1$. This is a circularly polarized wave. Prove that it can be decomposed into two linearly polarized waves.

Problem P2.4

Wave polarization can be viewed by either taking a series of still pictures at several fixed times, called the spatial view point or by making observations at a fixed point in space, called the temporal view point. We define polarization from the temporal view point. Let us now look at polarization from the spatial view point.

Consider an electromagnetic wave with $k = 100\text{K}_o$ propagating in the \hat{z} direction.

$$\overline{E}(\vec{r}, t) = E_0[\hat{x} \cos(kz - \omega t) + \hat{y} \sin(kz - \omega t)]$$

What is the wavelength and the polarization of this wave?

From the spatial point of view, by taking a picture at $t = 0$, the tips of the electric field vectors form a helix. Is the helix right-handed or left-handed? What is the pitch(wavelength) of this helix?

Problem P2.5

The Earth receives over all frequency bands about 1.5 kW/m^2 of power from the Sun.

- The Earth-Sun distance is 150×10^9 m. How long does it take the sunlight to reach the Earth?
- The Earth radius is 6400 km. What is the total power received by the Earth?
- Assume the Sun's mass is 2×10^{30} kg which converts to radiated energy according to mc^2 at 1 percent efficiency. How long can the Sun radiate at the present level?
- The Sun radiates $10^{-20} \text{ W m}^{-2} \text{ Hz}^{-1}$ at 3 GHz. Assuming constant power level over 1 GHz bandwidth, what is the Poynting power density and the corresponding electric field amplitude?