

Advanced Electromagnetic Theory

PHYS: 5333, Home Work #3

Due date: March 31, 2009

Submit only bold * problems

- [1.] Jackson 6.11, 7.1, 7.2 , **7.3***, 7.4, **7.5***, **7.6***, [**Bonus (optional) 7.8***, **7.9***] ,
[2.] Griffith: 9.9, 9.10, 9.11, 8.14, 9.16, 9.17, 9.18, 9.19, 9.20, 9.21, 9.27, 9.28, **9.29***, 9.30, 9.34, **9.36***, **9.37***
[3.] For the electromagnetic wave

$$\vec{\mathcal{E}}(\vec{r}, t) = \left(\hat{x} + \hat{y}\sqrt{2}e^{i\pi/4} \right) \mathcal{E}_0 e^{i(kz-\omega t)}$$

determine the semi-major and minor axes of the polarization ellipse and the inclination of the major axis of the ellipse to the x axis.

- [4.] Determine the state of polarization of the electromagnetic waves, their helicities and the associated magnetic vectors.

$$\begin{aligned} (i) \quad \vec{\mathcal{E}}(\vec{r}, t) &= \left[\hat{e}_x \mathcal{E}_0 e^{i(kz-\omega t-\pi/4)} + \hat{e}_y \mathcal{E}_0 \sqrt{2} e^{i(kz-\omega t+\pi/4)} \right] \\ (ii) \quad \vec{\mathcal{E}}(\vec{r}, t) &= \left[\hat{e}_x \mathcal{E}_0 e^{i(kz-\omega t-\pi/4)} - \hat{e}_y \mathcal{E}_0 \sqrt{2} e^{i(kz-\omega t-\pi/4)} \right] \\ (iii) \quad \vec{\mathcal{E}}(\vec{r}, t) &= \left[\hat{e}_x \mathcal{E}_0 e^{i(kz-\omega t)} - i \hat{e}_y \mathcal{E}_0 e^{i(kz-\omega t)} \right] \\ (iv) \quad \vec{E}(\vec{r}, t) &= E_0 \left[\hat{x} \cos(kz - \omega t - \pi/4) + \hat{y} \sqrt{2} \cos(kz - \omega t + \pi/4) \right] \end{aligned}$$

Take \mathcal{E}_0 and E_0 to be real and positive.

- [5.] The electric vector of a plane electromagnetic wave is given by

$$\vec{\mathcal{E}}(z, t) = \hat{x} \frac{\mathcal{E}_0}{\sqrt{2}} e^{i(kz-\omega t)} + \hat{y} \frac{\mathcal{E}_0}{\sqrt{2}} e^{i(kz-\omega t+\pi/2)} .$$

(a) What is the state of polarization and helicity of this wave? What is the magnetic field of this wave?

(b) Assuming that this is the field of a 5.0 mW laser beam of diameter 1.0 mm, find the value of the field amplitude \mathcal{E}_0 .