Problem 7.9  For a wave characterized by the electric field

\[ \mathbf{E}(z,t) = \hat{x} a_x \cos(\omega t - kz) + \hat{y} a_y \cos(\omega t - k z + \delta) \]

identify the polarization state, determine the polarization angles \((\gamma, \chi)\), and sketch the locus of \(\mathbf{E}(0, t)\) for each of the following cases:

(a) \(a_x = 3 \text{ V/m}, a_y = 4 \text{ V/m},\) and \(\delta = 0\)
(b) \(a_x = 3 \text{ V/m}, a_y = 4 \text{ V/m},\) and \(\delta = 180^\circ\)
(c) \(a_x = 3 \text{ V/m}, a_y = 3 \text{ V/m},\) and \(\delta = 45^\circ\)
(d) \(a_x = 3 \text{ V/m}, a_y = 4 \text{ V/m},\) and \(\delta = -135^\circ\)

Problem 7.10  The electric field of a uniform plane wave propagating in free space is given by

\[ \mathbf{\tilde{E}} = (\hat{x} + j\hat{y})30e^{-j\pi z/6} \ (\text{V/m}) \]

Specify the modulus and direction of the electric field intensity at the \(z = 0\) plane at \(t = 0, 5,\) and \(10\) ns.

Problem 7.12  The electric field of an elliptically polarized plane wave is given by

\[ \mathbf{E}(z,t) = [-\hat{x}10 \sin(\omega t - k z - 60^\circ)] + \hat{y}30 \cos(\omega t - k z) \]  \ (\text{V/m})

Determine the following:
(a) The polarization angles \((\gamma, \chi)\).
(b) The direction of rotation.

Problem 7.17  In a medium characterized by \(\varepsilon_r = 9, \mu_r = 1,\) and \(\sigma = 0.1 \text{ S/m},\) determine the phase angle by which the magnetic field leads the electric field at 100 MHz.
**Problem 7.22** The electric field of a plane wave propagating in a nonmagnetic medium is given by

\[
E = 25e^{-30x} \cos(2\pi \times 10^9 t - 40x) \quad \text{(V/m)}
\]

Obtain the corresponding expression for \(H\).

**Problem 7.24** In a nonmagnetic, lossy, dielectric medium, a 300-MHz plane wave is characterized by the magnetic field phasor

\[
H = (\hat{x} - j\hat{z})e^{-2y}e^{-j9y} \quad \text{(A/m)}
\]

Obtain time-domain expressions for the electric and magnetic field vectors.

**Problem 8.2** A plane wave traveling in medium 1 with \(\varepsilon_1 = 2.25\) is normally incident upon medium 2 with \(\varepsilon_2 = 4\). Both media are made of nonmagnetic, nonconducting materials. If the electric field of the incident wave is given by

\[
E_i = 88 \cos(6\pi \times 10^9 t - 30\pi x) \quad \text{(V/m)}
\]

(a) Obtain time-domain expressions for the electric and magnetic fields in each of the two media.

(b) Determine the average power densities of the incident, reflected and transmitted waves.

**Problem 8.6** A 50-MHz plane wave with electric field amplitude of 50 V/m is normally incident in air onto a semi-infinite, perfect dielectric medium with \(\varepsilon_r = 36\). Determine the following:

(a) \(\Gamma\)

(b) The average power densities of the incident and reflected waves.

(c) The distance in the air medium from the boundary to the nearest minimum of the electric field intensity, \(|E|\).

**Problem 8.15** A 5-MHz plane wave with electric field amplitude of 10 (V/m) is normally incident in air onto the plane surface of a semi-infinite conducting material with \(\varepsilon_r = 4\), \(\mu_r = 1\), and \(\sigma = 100\) (S/m). Determine the average power dissipated (lost) per unit cross-sectional area in a 2-mm penetration of the conducting medium.