** a_x, a_y are the unit vector in x and y direction respectively.

1. Please describe the definition of plane wave polarization. What are the conditions for linear, elliptical and circular polarizations? What is the handedness for polarization? (10%)

2. A propagating electric field is given by

\[ E(z,t) = 100e^{-0.01z}\cos(\pi \times 10^7 t + \pi z - \frac{\pi}{4}) \text{V/m} \]

(a) Determine the attenuation constant, the wave frequency, the wavelength, the propagation velocity, and the phase shift.

(b) How far must the wave travel before its amplitude is reduced to 1.0 V/m? (10%)

3. A 10.0-MHz magnetic field travels in a fluid for which the propagation velocity is 1.0 \( \times 10^8 \) m/s. Initially, we have \( \mathbf{H}(0,0) = 2.0 \, \text{a}_x \) A/m. The amplitude drops to 1.0 A/m after the wave travels 5.0 m in the y direction. Find the general expression for this wave. (10%)

4. Given \( \mathbf{E}(y, t) = 10.0\cos(\omega t - \beta z)\mathbf{a}_x - 20.0\cos(\omega t - \beta z - 45^\circ)\mathbf{a}_y \) V/m.

Find the polarization and handedness. (10%)

5. Suppose, in a nonmagnetic medium of relative permittivity 3, that

\[ \mathbf{E}(y, t) = 4.0\sin(\pi \times 10^7 t - \beta y)\mathbf{a}_x + 9.0\cos(\pi \times 10^7 t - \beta y)\mathbf{a}_x \text{ V/m} \]

Determine \( \beta \) and \( \mathbf{H}(y, t) \). (10%)
6. Figure 1, a cylindrical capacitor consists of an inner conductor of radius $a$ and an outer conductor whose inner radius is $b$. The space between the conductors is filled with a dielectric of permittivity $\varepsilon$, and the length of the capacitor is $L$. Determine the capacitance of this capacitor. (15%)

![Figure 1](image)

7. Please explain clearly about the Gauss’ law. (8%)

8. In figure 2, two particles of charges $q_1$ and $q_2$ are separated by distance $d$. The net electric field due to the particles is zero at $x = d/4$. With $V = 0$ at infinity, locate (in terms of $d$) any point on the x axis (other than at infinity) at which the electric potential due to the two particles is zero. (12%)

![Figure 2](image)

9. In Fig. 3, current $i = 56.2$ mA is set up in a loop having two radial lengths and two semicircles of radii $a = 5.72$ cm and $b = 9.36$ cm with a common center $P$. What are the (a) magnitude and (b) direction (into or out of the page) of the magnetic field at $P$ and the (c) magnitude and (d) direction of the loop’s magnetic dipole moment? (15%)

![Figure 3](image)