ENEL 476 W2020

Assignment #1

1. Consider the following electric field in distilled water (ε_r=81, μ_r=1, σ=0):

$$\mathbf{E}(x,t) = 250\cos(2\pi x10^8 t - 6\pi x)\,\mathbf{a}_y \text{ V/m.}$$

a) Calculate the displacement current density ($\mathbf{J}_d(x,t)$).
b) Calculate the associated magnetic field ($\mathbf{H}(x,t)$).
c) If the distilled water is placed in a PEC container, what are the electric and magnetic field inside the PEC?

2. Consider a magnetic flux density of $\mathbf{B}$=10 cos(120πt) $\mathbf{a}_z$ mW/m^2. Consider a conducting loop of radius 0.1 m that has surface normal oriented in the z direction.

a) Calculate the total flux passing through the surface of the loop.
b) Calculate the EMF induced in the loop.
c) If the loop contains a resistor of 10 Ω, find the induced current flowing in the loop.
d) Sketch the loop and indicate the direction of current flow. Explain how the induced current satisfies Lenz's law.

3. A square loop of wire has side length of 25 cm and has a resistance of 125 Ω per meter length. The loop lies in the z=0 plane with corners at (0,0.0), (0.25,0,), (0.25,0.25,0) and (0,0.25,0) at t=0. The loop moves with velocity 50 m/s in the y direction. There is also a magnetic flux density present that is described by:

$$\mathbf{B}=8\cos(1.5 \times 10^8 t - 0.5\,x)\mathbf{a}_z\ \mu\text{T}$$

a) Sketch this scenario.
b) Calculate the total flux passing through the surface of the loop.
c) Calculate the induced current.