

## ENEL 476 W2020

### Assignment #1

1. Consider the following electric field in distilled water ( $\epsilon_r=81$ ,  $\mu_o=1$ ,  $\sigma=0$ ):

$$\mathbf{E}(x,t) = 250 \cos(2\pi \times 10^8 t - 6\pi x) \mathbf{a}_y \text{ V/m.}$$

- Calculate the displacement current density ( $\mathbf{J}_d(x,t)$ ).
- Calculate the associated magnetic field ( $\mathbf{H}(x,t)$ ).
- 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  $\mathbf{B}=10 \cos(120\pi t) \mathbf{a}_z \text{ mW/m}^2$ . Consider a conducting loop of radius 0.1 m that has surface normal oriented in the z direction.

- Calculate the total flux passing through the surface of the loop.
- Calculate the EMF induced in the loop.
- If the loop contains a resistor of  $10 \Omega$ , find the induced current flowing in the loop.
- 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  $125 \Omega$  per meter length. The loop lies in the  $z=0$  plane with corners at  $(0,0,0)$ ,  $(0.25,0,0)$ ,  $(0.25,0.25,0)$  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:

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

- Sketch this scenario.
- Calculate the total flux passing through the surface of the loop.
- Calculate the induced current.

