

EEC 130A: Homework 9

Due: 3:30 pm, Mar. 16th, 2012

Updated: Mar. 11th, 2012

1. (4 points) (FAE P5.40) The rectangular loop shown in Fig. 1 is coplanar with the long, straight wire carrying the current $I = 20 \text{ A}$. Determine the magnetic flux through the loop.

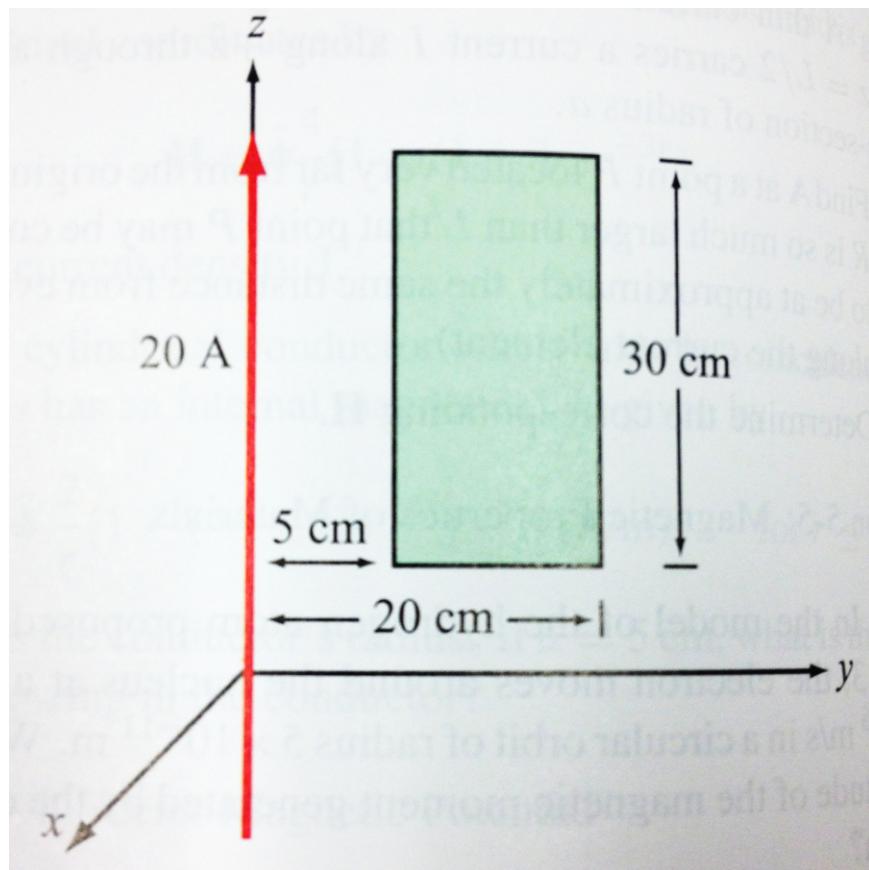


Figure 1: Loop and wire arrangement for Problem 1.

2. (4 points) (FAE P6.6) The square loop shown in Fig. 2 is coplanar with a long, straight wire carrying a current

$$I(t) = 5 \cos(2\pi \times 10^4 t)$$

- (a) Determine the emf induced across a small gap created in the loop.

- (b) Determine the direction and magnitude of the current that would flow through a $4\text{-}\Omega$ resistor connected across the gap. The loop has an internal resistance of $1\text{ }\Omega$.

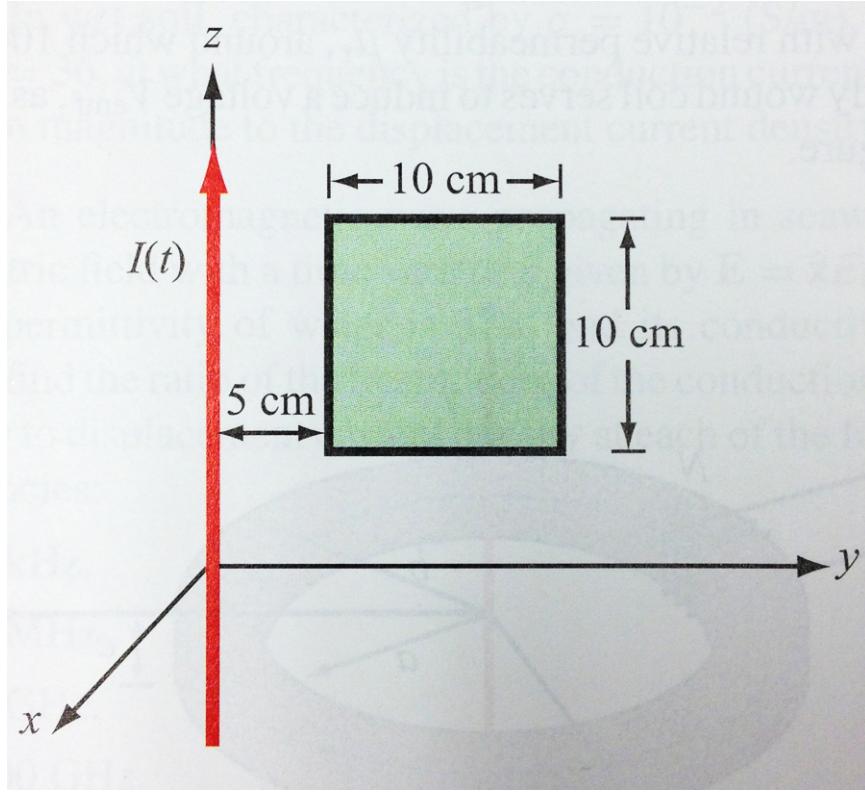


Figure 2: Loop coplanar with long wire (Problem 2).

3. (4 points) (FAE P6.11) The loop shown in Fig. 3 moves away from a wire carrying a current $I_1 = 10\text{ A}$ at a constant velocity $\mathbf{u} = \hat{\mathbf{y}}7.5\text{ (m/s)}$. If $R = 10\text{ }\Omega$ and the direction of I_2 is as defined in the figure, find I_2 as a function of y_0 , the distance between the wire and the loop. Ignore the internal resistance of the loop.

4. (4 points) (FAE P6.15) A coaxial capacitor of length $l = 6\text{ cm}$ uses an insulating dielectric material with $\epsilon_r = 9$. The radii of the cylindrical conductors are 0.5 cm and 1 cm . If the voltage applied across the capacitor is

$$V(t) = 50 \sin(120\pi t) \quad (\text{V})$$

what is the displacement current?

5. (4 points) (FAE P6.16) The parallel-plate capacitor shown in Fig. 4 is filled with a lossy dielectric material of relative permittivity ϵ_r and conductivity σ . The separation between the plates is d and each plate is of area A . The capacitor is connected to a time-varying voltage source $V(t)$.

- (a) Obtain an expression for I_c , the conduction current flowing between the plates inside the capacitor, in terms of the given quantities.

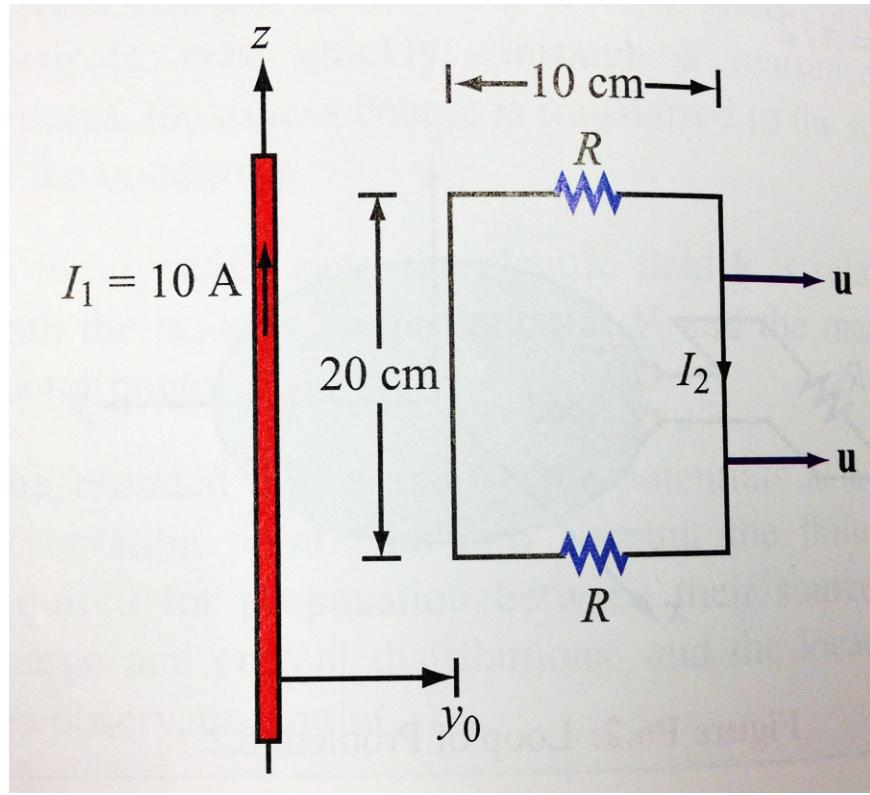


Figure 3: Moving loop of Problem 3.

- (b) Obtain an expression for I_d , the displacement current flowing inside the capacitor.
- (c) Based on your expressions for parts (a) and (b), give an equivalent-circuit representation for the capacitor.
- (d) Evaluate the values of the circuit elements for $A = 4 \text{ cm}^2$, $d = 0.5 \text{ cm}$, $\epsilon_r = 4$, $\sigma = 2.5 \text{ (S/m)}$, and $V(t) = 10 \cos(3\pi \times 10^3 t) \text{ (V)}$.

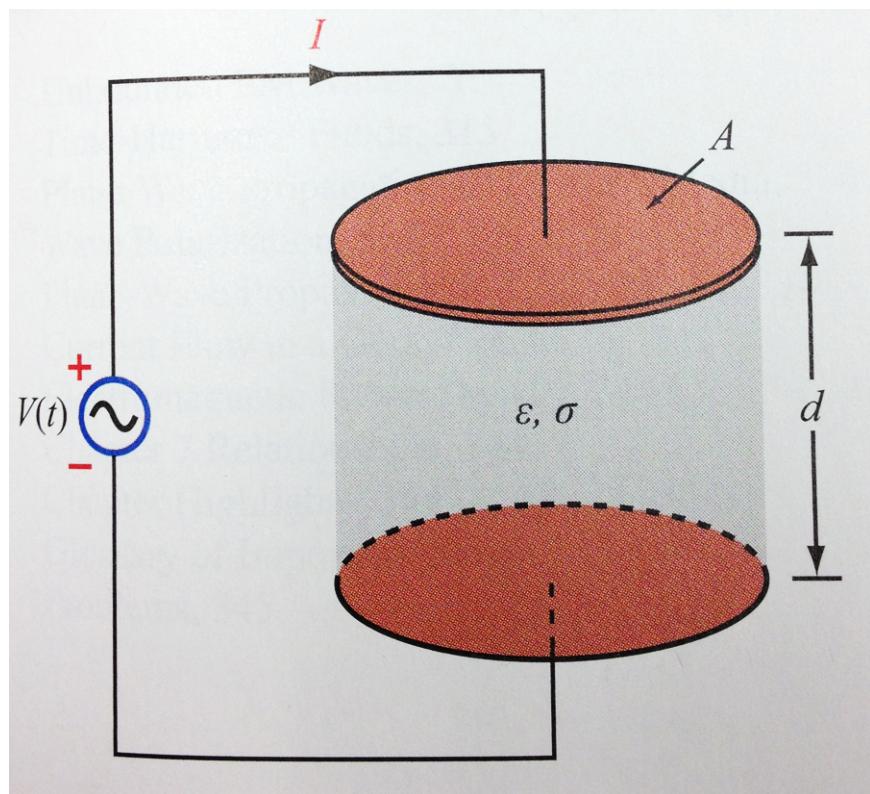


Figure 4: Parallel-plate capacitor containing a lossy dielectric material (Problem 5).