Problem Set 8, 29 October 2018 Name: _______________ , Section: ___

Problem – (E34.30) A long solenoid has a diameter of 12.6 cm. When a current i is passed through its windings, a uniform magnetic field $B = 28.6$ mT is produced in its interior. By decreasing i, the field is caused to decrease at the rate 6.51 mT/s. Calculate the magnitude of the induced electric field

a) 2.20 cm and

b) 8.20 cm from the axis of the solenoid.

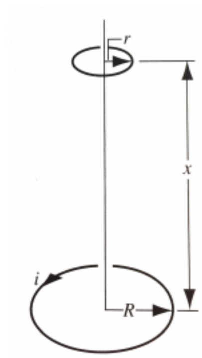
Solution:

Problem – (P34.6)* The figure below shows two parallel loops of wire having a common axis. The smaller loop (radius r) is above the larger loop (radius R), by a difference $x \gg R$. Consequently the magnetic field, due to the current i in the larger loop, is nearly constant throughout the smaller loop and equal to the value on the axis. Suppose that x is increasing at the constant rate $dx/dt = v$.

a) Determine the magnetic flux across the area bounded by the smaller loop as a function of x.

b) Compute the emf generated in the smaller loop.

c) Determine the direction of the induced current flowing in the smaller loop.



Solution:

Problem – (P34.9)

a) Find an expression for the energy density as a function of the radial distance r for a toroid of rectangular cross section.

b) Integrating the energy density over the volume of the toroid, calculate the total energy stored in the field of the toroid.

c) Using Eq. 36-10, evaluate the energy stored in the toroid directly from the inductance and compare with (b).

Solution:

Problem – (E36.21) In the circuit shown in the figure below, $\mathscr{E} = 10$ V, $R_1 = 5.0\Omega$, $R_2 = 10\Omega$, and $L = 5.0$ H. For the two separate conditions

(I) switch S just closed and

(II) switch S closed for a long time,

calculate

a) the current i_1 through R_1,

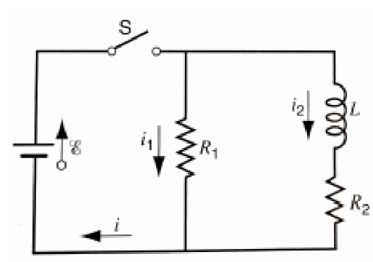
b) the current i_2 through R_2,

c) the current i through the switch,

d) the potential difference across R_2,

e) the potential difference across L, and

f) di_2/dt.



Solution:

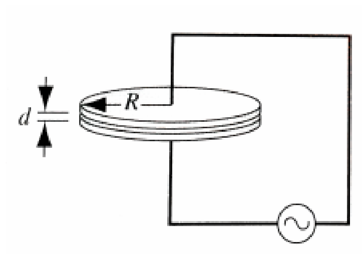
Problem – ¶(P38.3) The capacitor in the figure below consisting of two circular plates with radius $R = 18.2$ cm is connected to a source of emf $\mathscr{E} = \mathscr{E}_m \sin(\omega t)$, where $\mathscr{E}_m = 225$ V and $\omega = 128$ rad/s. The maximum value of the displacement current is $i_d = 7.63\ \mu$A. Neglect fringing of the electric field at the edges of the plates.

a) What is the maximum value of the current i?

b) What is the maximum value of $d\Phi_E/dt$, where Φ_E is the electric flux through the region between the plates?

c) What is the separation d between the plates?

d) Find the maximum value of the magnitude of $\mathbf{B}$ between the plates at a distance $r = 11.0$ cm from the center.



Solution:

Problem – ¶Supplementary Problem 3 A parallel plate capacitor has circular plates of radius R and separation d. The capacitor is connected to a battery of voltage V and then disconnected so that the charge ought to remain constant. The air is humid, however, and therefore slightly conducting; thus the stored charge leaks back across the air gap between the capacitor plates at rate i_{leak}. Assume that this leakage current is uniformly distributed across the area of the plates. Find the magnetic field everywhere between the plates.

Solution:

Problem – ¶Supplementary Problem 4 In a material of non-zero electrical resisitivity ρ, the relationship between electric field and current density is $\mathbf{E} = \rho\mathbf{j}$. For copper, $\rho = 2 \times 10^{-8}\ \Omega \cdot \text{m}$. A copper wire with a circular cross-sectional area of 4 mm^2 carries a current of 40 A.

a) What is the longitudinal electric field (field along the length of the wire) in the copper?

b) If the current is changing at a rate of 5000 A/s, at what rate is **E** changing, and what is the resulting displacement current?

c) Does the displacement current contribute significantly to the magnetic field outside the wire? Explain your answer.

Solution: