

EE2104 Introduction to Electromagnetics
Assignment 3

Deadline (for uploading): 11:59 pm, 2 Dec 2022
Please put down your name and university ID.

1. Given the expression of the B -field at distance z directly above the center of a circular coil of radius a carrying current I is

$$B = \frac{\mu_0}{2} \frac{Ia^2}{(z^2 + a^2)^{3/2}}$$

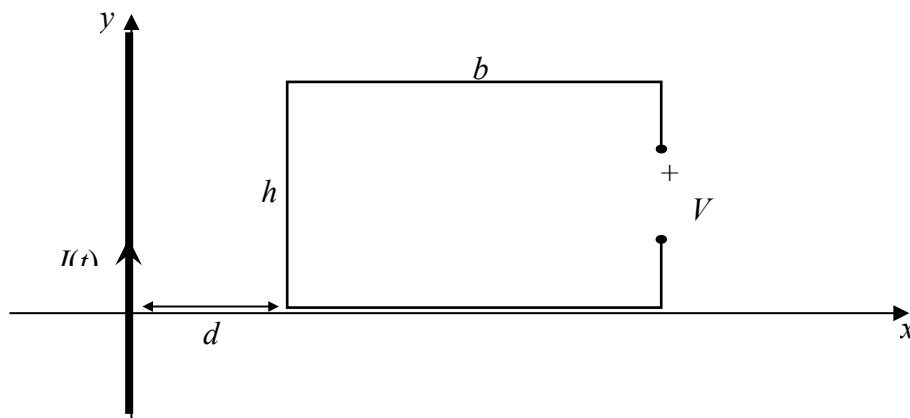
A stack of the coils are connected in series to form a solenoid of turn density n . The solenoid is centered along the z -axis. It has a finite length extending from $z = -d/2$ to 0 . By superposition, find B at the $(x, y, z) = (0, 0, +d/2)$.

2. Consider a long coaxial cable of inner and outer radii a and b , respectively. The gap is filled with air. The length of the cable is L . Find
- the capacitance C using Gauss's law,
 - the inductance L using Ampere's law, and
 - calculate a value called the characteristic impedance $Z = (L/C)^{1/2}$ if $b = 5$ mm, and $a = 1$ mm.

3. An infinitely long wire of current I flowing towards the $+y$ -direction is put on the y -axis. The current is:

$$I = I_0 \exp(-\gamma_0 t)$$

where I_0 is the amplitude and γ_0 is a rate. A rectangular open wire loop of height h and width b is put at distance d away, as the following figure shows. Find the induced voltage V across the loop.



4. The following considers electromagnetic wave propagating in free-space (without charges or currents).
- State the Maxwell's equations in terms of $\mathbf{E}$ and $\mathbf{H}$ for the free-space.
 - Show** that the four equations are satisfied by:

$$\mathbf{E} = E_0 \cos\left(\omega\left(\frac{z}{c} - t\right)\right) \hat{\mathbf{x}}$$

$$\mathbf{H} = \frac{E_0}{c\mu_0} \cos\left(\omega\left(\frac{z}{c} - t\right)\right) \hat{\mathbf{y}}$$

for some constants E_0 and ω , where c is the speed of light in free-space.