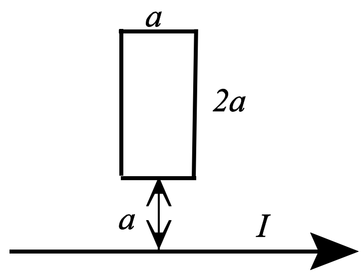
Phys 321 – E & M II – Test 1 – Sept. 14, 2001

1. (25 pts) A rectangular loop of wire of sides a and $2a$ lies a distance a from a long straight wire, which carries a current I.



a) Find the magnetic flux through the loop.

b) If the current in the wire varies as $I(t) = I_0 \sin(\omega t)$, where I_0 and ω are constants, determine the emf induced in the loop.

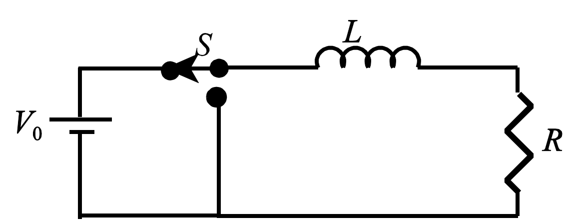
c) If, instead, the current in the wire is constant and the loop is pulled away from the wire, will current flow in the wire? And, if so, in what direction (clockwise (CW) or cou;nter-clockwise (CCW)) does the current flow?

2. (25 pts) A long solenoid with radius a and n turns per unit length carries a time-dependent current $I(t)$ in the $\hat{\phi}$ direction. Find the electric field (magnitude and direction) at a distance s from the axis (both inside and outside the solenoid), in the quasistatic approximation.

3. (25 pts) A long solenoid with radius a and n_1 turns per unit length carries a current I. A short solenoid (length R and radius b, with n_2 turns per unit length) surrounds the long solenoid ($b > a$) and is coaxial with it.

a) Find the magnetic flux through the short solenoid.

b) Determine the mutual inductance of the long and short solenoids.



4. (25 pts) Suppose the circuit shown has been connected for a long time when suddenly at time $t = 0$, switch S is thrown, bypassing the battery.

a) What is the current in the solenoid after a long time?

a) Determine the current at any subsequent time.

b) Determine the total energy delivered to the resistor.

Recall: $\int_0^\infty x^n e^{-ax} dx = \dfrac{n!}{a^{n+1}}$