

Massachusetts Institute of Technology

Spring Term 2005

8.02X Electricity and Magnetism

Practice-Quiz #4b

Problem 1 (25 points)

In the HVPS experiment, you built a “transformer” by winding 6 loops of wire around a tightly wound red coil.

- (a) Which side of the transformer was the primary side in this setup?

- (b) Assume that in your setup the inner (red) coil had length L_1 , number of windings N_1 and radius R_1 . The outer coil (wire loops) had length L_2 , number of windings N_2 and radius R_2 . Derive an expression for the mutual inductance of the two coils. Show work!

- (c) Based on the known output voltages of LVPS and HVPS, estimate (within a factor of 2) a numerical value for the number of windings of the red coil (ignore the different length for primary and secondary coil).

- (d) Assume a current $I_2(t) = I_0 * \cos(\omega t)$ was flowing through the outer coil. What would the voltage across the red coil $\Delta V_1(t)$ be?

Problem 2 (25 points)

Shown below is a circuit that is connected to a DC power supply with an output voltage V_0 . For times $t < 0$, the switch is in position 1 and a current is flowing through the inductor (inductance L), the resistor (resistance R) and the power supply. Assume the switch has been closed for a very long time and the resistance of the inductor is negligible. Assume also that for $t < 0$, the capacitor (Capacity C) is discharged ($Q=0$).

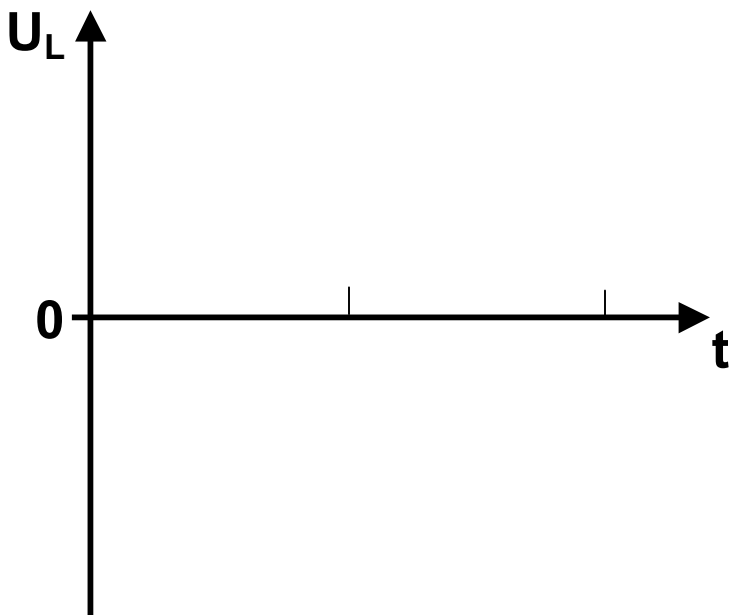
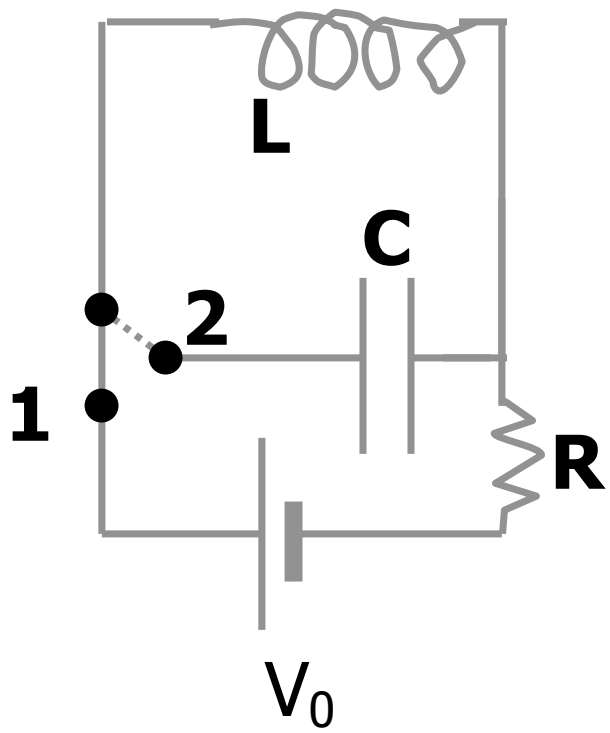
At $t=0$, the switch is moved to position 2 and the power supply and resistor are therefore removed from the circuit.

- (a) At $t=0$, what is the total energy stored in the circuit formed by capacitor and inductor?

- (b) Give an example (sketch) of a mechanical system that corresponds to the circuit formed by the inductor and capacitor (after $t=0$). Identify which elements in the mechanical system correspond to which circuit elements.

- (c) How will the charge $Q(t)$ on the capacitor vary with time? Give an equation in terms of the quantities defined above.

- (d) On the graph below, sketch how the energy in the inductor varies with time after $t=0$.



Problem 3 (25 points)

Consider a plane wave with an amplitude that is described by the following equations:

$$A_x = 0$$

$$A_y = 0$$

$$A_z = A_0 \cos(\omega t - (2\pi/3\text{m}) x)$$

- (a) Which direction is the wave traveling in?**
- (b) How big is the wave length of the wave?**
- (c) Could these equations describe a sound wave? Explain your answer.**
- (d) If the wave was electromagnetic, what would the frequency f be?**

Problem 4 (25 points) AMP experiment

- (a) What is the purpose of the AMP experiment? (1-2 sentences)
- (b) How did you calibrate the AMP setup? What does the calibration curve tell you? (2-3 sentences)
- (c) Shown below is a calibration circuit like that on the AMP experiment. All voltages are measured relative to the common line C, which is defined as 0V. What is the voltage at point X when the slider of the potentiometer is 1/2 way between the extreme positions?
- (d) What are the maximum and minimum voltages at point D relative to C, when the slider is moved from one extreme position to the other?

