Physics 110A: Problem Set #2

Due Monday, October 15 by 12:30 pm

Reading: MT chapter 3 ; lecture notes packet #3

[1] Consider a harmonic oscillator. Compute the *time* averages of the kinetic and potential energies over one cycle, and show that they are equal. Why is this so? Next calculate the *space* averages of kinetic and potential energies. Discuss your results.

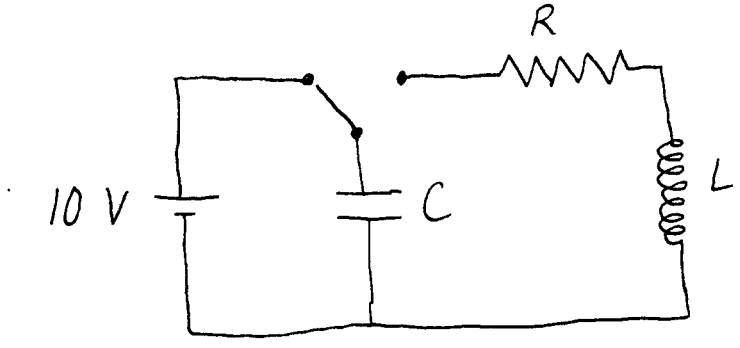
[2] Show that for a lightly damped oscillator driven near resonance, the Q of the system is approximately given by

$$Q = 2\pi \cdot \left(\frac{\text{total energy}}{\text{energy loss during one cycle}} \right) .$$

[3] At time $t = 0$ the switch below is thrown to the right, completing a series L-C-R circuit. The inductance is $L = 10\,\text{mH}$ and the resistance is $R = 100\,\Omega$. The resonant (angular) frequency of the circuit is $\Omega_{\text{R}} = 10\,\text{kHz}$.

(a) What is the value of the capacitance C?

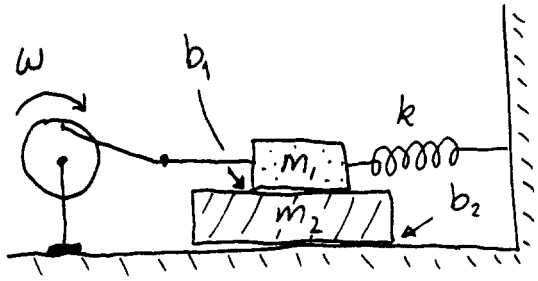
(b) What is the magnitude and direction of the current which flows through the circuit at time $t = 1.0\,\text{ms}$?



[4] The figure below depicts a mechanical system driven by a sinusoidal force of angular frequency ω. The mass m_1 is attached to a rigid support by a spring of force constant k and slides on a second mass m_2, which itself slides along a table. The frictional force between m_1 and m_2 is represented by the damping parameter b_1, and the frictional force between m_2 and the table is b_2.

(a) Write down the mechanical equations of motion for this system.

(b) Construct its electrical analog. What is its impedance?



[5] Obtain the response of a linear oscillator to the forcing function

$$f(t) = a \sin(\omega t)\, \Theta(t)\Theta(\pi - \omega t) \ .$$