Physics 25 Problem Set 2

Harry Nelson

due Monday, April 17

Please make your work neat, clear, and easy to follow. It is hard to grade sloppy work accurately. Generally, make a clear diagram, and label quantities. Derive symbolic answers, and then plug in numbers after a symbolic answer is available.

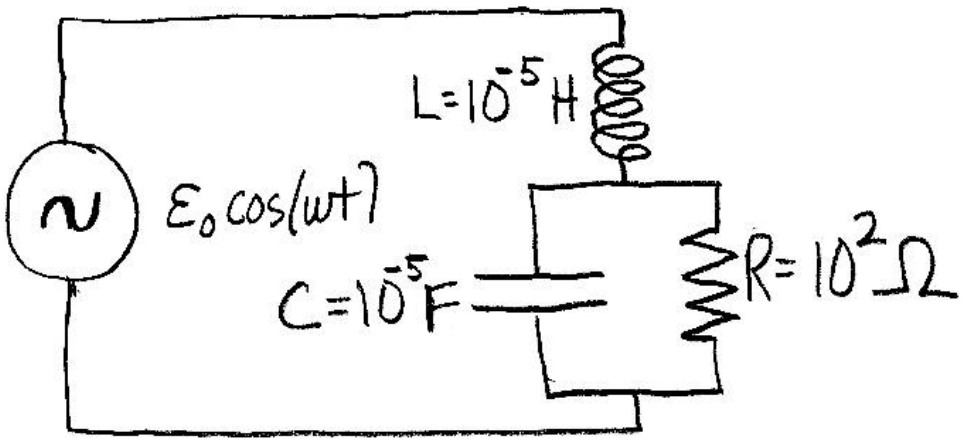

Figure 1: For use in Problem 1.

1. A power supply provides a sinusoidal voltage with $\varepsilon_0 = 10\,\mathrm{V}$ that is applied to the circuit shown in Fig. 1. The values of the passive components are $L = 10^{-5}\,\mathrm{H}$, $C = 10^{-5}\,\mathrm{F}$, and $R = 100\,\Omega$. The frequency ω is varied between $\omega_1 = 5 \times 10^4\,\mathrm{Hz}$ and $\omega_2 = 2 \times 10^5\,\mathrm{Hz}$.

   (a) Evaluate and plot the magnitude of the peak current flowing out of the power supply as a function of ω for ω between ω_1 and ω_2, and use a logarithmic scale for the peak current. For what frequency ω_0 is the peak current a maximum?

   (b) Evaluate and plot the phase between the current and the voltage for the same range of ω.

   (c) Evaluate and plot the average power dissipated in the circuit for the same range of ω, and use a logarithmic scale for the power. How does the peak power dissipation compare with the very naive estimate of $\varepsilon_0^2/(2R)$?

   (d) Evaluate and plot the average power dissipated in the circuit for a very narrow range of ω, between $\omega_1 = 0.98 \times 10^5\,\mathrm{Hz}$ and $\omega_2 = 1.02 \times 10^5\,\mathrm{Hz}$. Find the two frequencies where the power dissipation is one-half of the peak power; denote the difference between the two frequencies as $2\Delta\omega$, and evaluate $\omega_0/(2\Delta\omega)$, and compare this quantity to $R/(\omega_0 L)$.

2. Purcell 9.2

3. Purcell 9.5

4. Purcell 9.9

5. Purcell 9.10
