Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 3 – IPSP

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Exercise Sheet 3 (WS 2012/13)

Date of Issue to Students: Oct. 26^{th} 2012

Date of Submission: Nov. 2^{nd} 2012

Submission Place: Marked mailbox next to room 302 (Linnestr. 5)
Submission Time: 11:00 a.m. at the submission day noted above

Please note: Write your name and matriculation number on EACH sheet of paper.
Only submit the calculations and results for exercise 1-3, exercise 4 will be discussed during the instruction classes.

Exercises:

1. A 5.0-μF capacitor is charged to 30 V and is then connected across an ideal 10-mH inductor. (a) How much energy is stored in the system? (b) What is the frequency of oscillation of the circuit? (c) What is the peak current in the circuit? (6 Points)

2. The circuit shown in Figure 1 is called an RC high-pass filter because it transmits input voltage signals that have high frequencies with greater amplitude than it transmits input voltage signals that have low frequencies. If the input voltage is given by $V_{in} = V_{in,peak} \cos \omega t$, show that the output voltage is $V_{out} = V_H \cos(\omega t - \delta)$ where $V_H = V_{in,peak} / \sqrt{1 + (\omega RC)^{-2}}$. (Assume that the output is connected to a load that draws only an insignificant amount of current.) Draw a phasor diagram and show that this result justifies calling this circuit a high-pass filter. (9 Points)

3. (a) Find an expression for the phase constant δ in Problem 2 in terms of ω, R and C. (b) What is the value of δ in the limit that $\omega \to 0$? (c) What is the value of δ in the limit that $\omega \to \infty$ (5 Points)

4. In the circuit shown in Figure 2, let the voltage be $\epsilon_0 = 12.0$ V, the resistance $R = 3.00\,\Omega$, and the inductivity $L = 0.600$ H. The switch is closed at time $t = 0$. During the time from $t = 0$ to $t = L/R$, find (a) the amount of energy supplied by the battery, (b) the amount of energy dissipated in the resistor, and (c) the amount of energy delivered to the inductor. Hint: Find the energy transfer rates as functions of time...

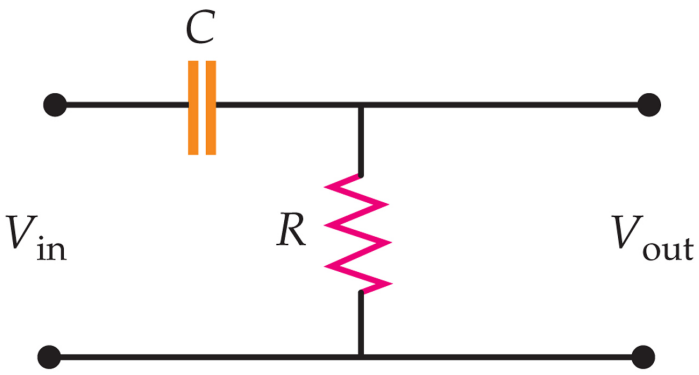

Figure 1: Exercise 2

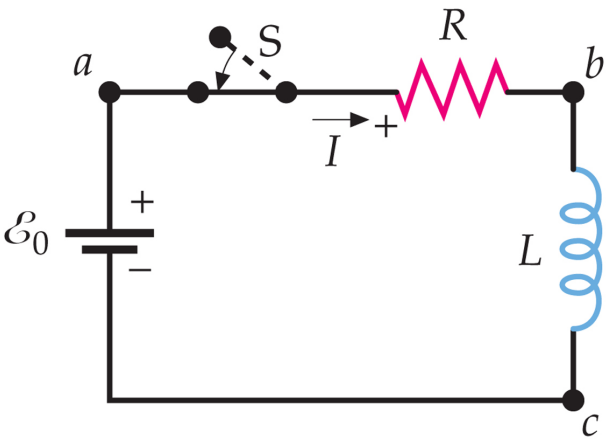

Figure 2: Exercise 4