Universität Leipzig, Fakultät für Physik und Geowissenschaften

Exercises for Experimental Physics 3 – IPSP

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Exercise Sheet 2 (WS 2012/13)

Date of Issue to Students: Oct. 19th 2012

Date of Submission: Oct. 26st 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. In Figure 1, circuit 2 has a total resistance of 300 Ω. After switch S is closed, the current in circuit 1 increases – reaching a value of 5.00 A after a long time. A charge of 200 μC passes through the galvanometer in circuit 2 during the time that the current in circuit 1 is increasing. What is the mutual inductance between the two coils? (7 Points)

2. A long cylindrical wire has a radius equal to 2.0 cm and carries a current of 80 A uniformly distributed over its cross-sectional area. Find the magnetic energy per unit length within the wire. (7 Points)

3. A circuit consists of a coil that has a self-inductance equal to 5.00 mH and an internal resistance equal to 15.0 Ω, an ideal 12.0-V battery and an open switch – all connected in series (Figure 2). At $t = 0$ the switch is closed. Find the time when the rate at which energy is dissipated in the coil equals the rate at which magnetic energy is stored in the coil. (6 Points)

4. A toroid has a rectangular cross section as shown in Figure 3. Show that the self-inductance is

$$L = \frac{\mu_0 N^2 h}{2\pi} \ln \frac{r_2}{r_1},$$

where N is the total number of turns and r_1, r_2 and h are the dimension as shown in Figure 3. Hint: Start with Ampère's law to get B.

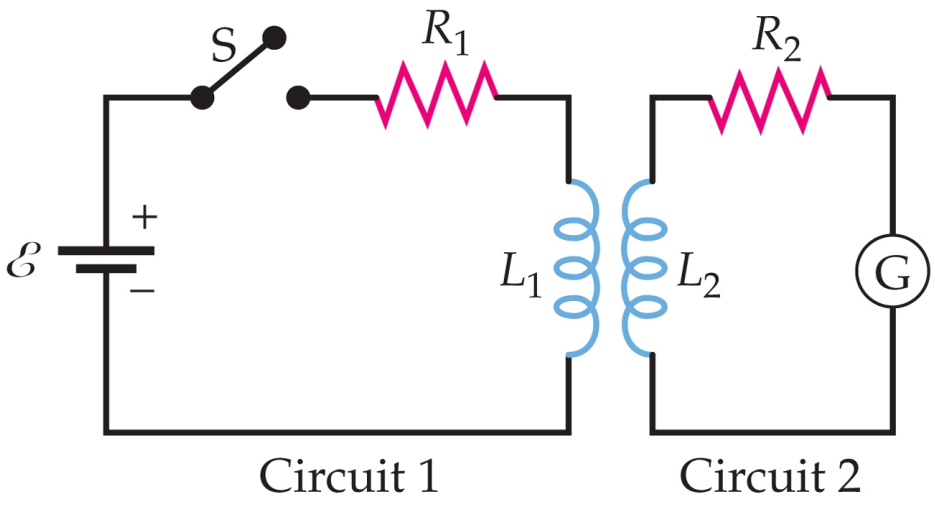

Figure 1: Exercise 1

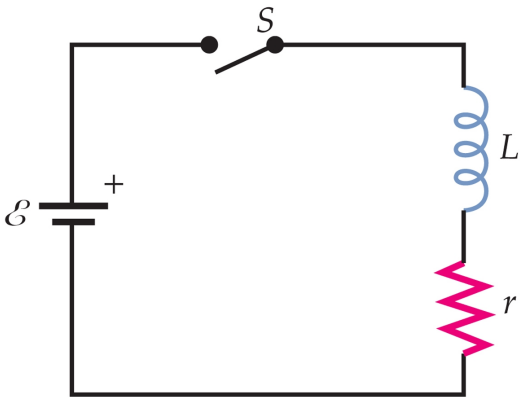

Figure 2: Exercise 3

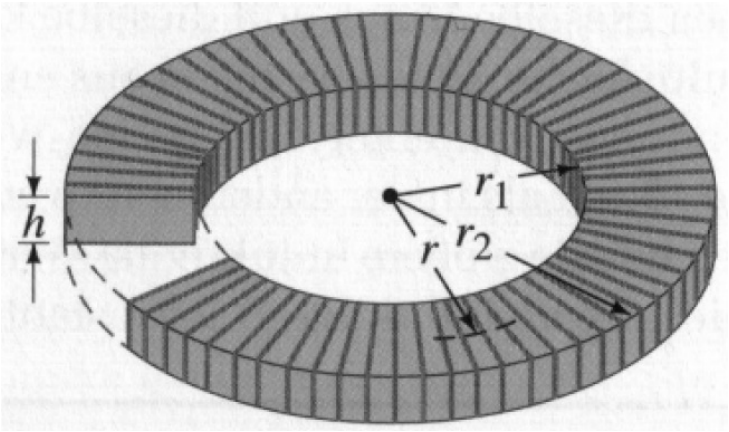

Figure 3: Exercise 4