THE UNIVERSITY OF BRITISH COLUMBIA

Physics 122 Assignment # 9:
INDUCTANCE & CIRCUITS

Fri. 8 Mar. 2002 — finish by Fri. 15 Mar.

1. **Solenoid as an *RL* Circuit:** A long wire with net resistance $R = 150\ \Omega$ is wound onto a nonmagnetic spindle to make a solenoid whose cross-sectional area is $A = 0.015\ \text{m}^2$ and whose effective length is $\ell = 0.40$ m. (Treat the coil as an ideal, long solenoid.) Using a battery with a 1 MΩ internal resistance, a magnetic field of $B_\circ = 0.5$ T has been built up inside the solenoid. At $t = 0$ the battery is shorted out and then disconnected so that the current begins to be dissipated by the coil's resistance R. We find that after 3.0 ms the field in the coil has fallen to 0.1 T.

(*a*) How many joules of energy are stored in the coil at $t = 0$?

(*b*) How long does it take for the stored energy to fall to half its initial value?

(*c*) What is the total number of turns in the coil?

2. ***LC* Circuit Time-Dependence:** In an LC circuit with $C = 90\ \mu$F the current is given as a function of time by $I = 3.4\cos(1800t + 1.25)$, where t is in seconds and I is in amperes.

(*a*) How soon after $t = 0$ will the current reach its maximum value?

(*b*) Calculate the inductance.

(*c*) Find the total energy in the circuit.

3. **Build Your Own Circuit:** You are given a 12 mH inductor and two capacitors of 7.0 and 3.0 μF capacitance. List all the *resonant frequencies* that can be produced by connecting these circuit elements in various combinations.

4. ***LRR* Circuit Time-Dependence:** In the circuit shown, the $\mathcal{E} = 12$ V battery has negligible internal resistance, the inductance of the coil is $L = 0.12$ H and the resistances are $R_1 = 120\ \Omega$ and $R_2 = 70\ \Omega$. The switch **S** is closed for several seconds, then opened. Make a quantitatively labelled graph with an abscissa of *time* (in milliseconds) showing the *potential* of point **A** with respect to ground, just before and then for 10 ms after the opening of the switch. Show also the variation of the potential at point **B** over the same time period.