MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science

6.622 Power Electronics — Issued: February 6, 2023
Problem Set 0 — Due: February 13, 2023

Reading: KPVS Chapters 1 and 2

Problem 0.1

Figure 0.1 shows the circuit diagram of a magnetic stimulator made by an international biomedical electronics company. The pulsed magnetic field generated by the transducer coil (represented by the inductor) can be used in a variety of medical treatments including nerve stimulation. The capacitor is precharged to a Voltage V_x between 0 and 1000 V, and then at $t = 0$ the switch S is closed to trigger the magnetic pulse.

a. Calculate the following assuming that the switch S and the diode D are ideal:

1. The time response of the coil current after the switch S is closed, as a function of the precharge voltage V_x. (Some types of stimulation require a field with a fast rise time and a slow fall time.)

2. The peak coil current i_{coil} for $V_x = 900$ V.

3. The time t_1 at which diode D turns on.

4. The energy dissipated in the resistor for $V_x = 900$ V.

b. Using any time-domain simulation tool you want (e.g. LTSPICE, PSIM, Simulink, etc.), simulate the circuit for 1 ms after the switch is closed. Assume that $V_c = 900$ V when switch S is closed, focusing on the coil current and capacitor voltage. Note that the LTSPICE simulator can be obtained for free at:
http://www.linear.com/designtools/software/#LTspice

c. Considering that the system of Fig. 1.2 may be thought of as a switched *linear* system, can you predict how the coil current and capacitor voltage waveforms will scale in amplitude and/or time as the initial charge voltage V_c changes? Verify your prediction by running another simulation with an initial voltage $V_c = 450$ V.

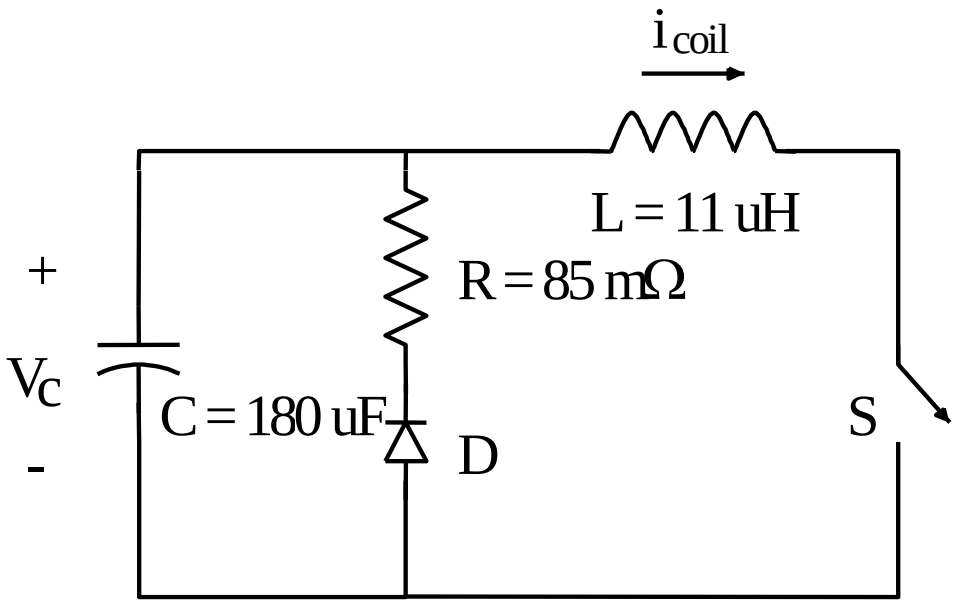

Figure 0.1 **Schematic of the magnetic stimulator circuit. The capacitor voltage Vc is precharged to 900 V when the switch S is closed.**

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