Warm-Up for May 3rd, 2022

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1 Memory Bank

1. Note about current and capacitors: $dQ/dt = I$, $Q = C\Delta V$.
2. *Flux rule for motional emf*: $\mathcal{E} = -d\Phi_B/dt$
3. Definition of self-inductance, or just **inductance**: $\Phi_B = LI$. This implies $\mathcal{E} = -L(dI/dt)$.

2 RC Circuits and RL Circuits

1. A capacitor C has been charged up to potential V_0; at time $t = 0$, it is connected to a resistor R, and begins to discharge (Fig. 1, left). (a) Determine the charge on the capacitor as a function of time, $Q(t)$. What is the current through the resistor, $I(t)$? (b) Show that the integral of $P(t) = I^2(t)R$, the energy delivered to the resistor, is $W = \frac{1}{2}CV_0^2$. (c) Now imagine charging up the capacitor (Fig. 1, middle). Determine $Q(t)$ and $I(t)$. (d) Find the total energy output of the battery ($\int V_0 I dt$). What fraction of the battery output shows up in the capacitor?

2. (a) For the RL circuit of Fig. 1 (right), what is $I(t)$? (b) What fraction of power is given to the inductor after a time $t = 10\tau = 10(L/R)$? What about 100τ?

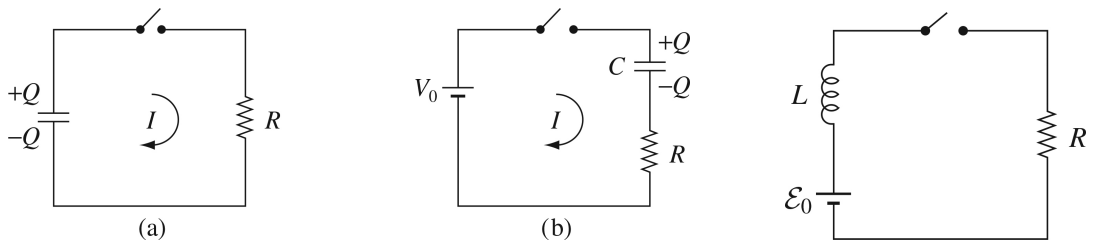

Figure 1: Two circuits: (left) pre-charged RC circuit, (middle) standard RC circuit with battery, and (right) the RL circuit.