Wednesday Reading Assessment: Unit 5, Field Induction and Inductance

Prof. Jordan C. Hanson

April 22, 2020

1 Memory Bank

- $\epsilon = -L\frac{dI}{dt}$ ... Faraday's law with induction, L. Think of this as the change in voltage across an inductor.
- Kirchoff's loop rule: the sum of all changes in voltage around a loop in a circuit must be zero.

2 RL Circuits

1. Consider the DC circuit in Fig. 1. There is a battery emf ϵ connected to a resistor R and and inductor L via switch 1. Switch 2 simply connects L and R. Suppose we observe the current through the circuit when switch 1 is closed to be

$$i(t) = \frac{\epsilon}{R}\left(1 - \exp(-t/\tau)\right) \tag{1}$$

(a) Based on Kirchhoff's loop rule, write down the differential equation describes the loop when switch 1 is closed. Note that $\tau = L/R$. (b) Plug in Eq. 1 into your differential equation to see if it works.

2. Now we repeat this exercise, but with switch 2 closed and switch 1 opened, after the circuit reaches equilibrium ($t \gg \tau$, when switch 1 was closed). The equation is observed to be

$$i(t) = \frac{\epsilon}{R}\exp(-t/\tau) \tag{2}$$

What formula do we obtain when we apply Kirchhoff's loop rule? (This is now the situation in part (c) of Fig. 1).

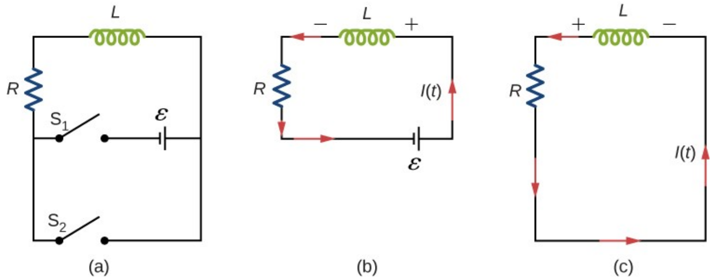

Figure 1: A circuit diagram of a DC emf with a resistor, inductor, and two switches.