

# Thursday Reading Assessment: Unit 4, Field Induction and Inductance

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## 1 Memory Bank

- $\epsilon = -L \frac{\Delta I}{\Delta t}$  ... 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  $\epsilon$  connected to a resistor  $R$  and an 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

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

(a) In terms of the variables given, what is the current at time  $t = 0$ , when switch 1 is closed? (b) In terms of the variables given, what is the current when  $t$  is much larger than  $\tau$ ? (This is like the situation in part (b) of Fig. 1).

2. After switching out the resistor and inductor independently, we determine that  $\tau = L/R$ . (a) What is  $\tau$  when  $R = 1 \text{ k}\Omega$ , and  $L = 0.2 \text{ Henrys}$ ? (The units should be seconds). (b) What will the time constant  $\tau$  be if we double  $R$  and quadruple  $L$ ?

3. Now we return to experimenting, to find out what happens when switch 2 is closed and switch 1 is opened. We do this after switch 1 has been closed for a long time, so that initially,  $i \approx \epsilon/R$ . The equation is observed to be

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

What time passes before the current is reduced to half of its original value?

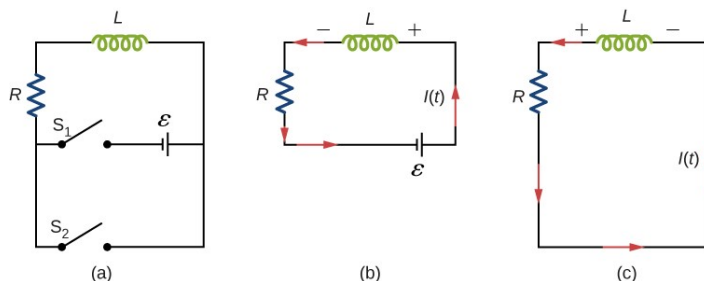


Figure 1: A circuit diagram of a DC emf with a resistor, inductor, and two switches.