Tuesday Reading Assessment: Unit 4, Field Induction and Inductance

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1 Memory Bank

- $\epsilon = -N\Delta\phi_m/\Delta t$ ... Faraday's Law, with flux ϕ
- $\epsilon = -L\Delta I/\Delta t$ ... Faraday's Law, with inductance L
- $\epsilon_2/\epsilon_1 = N_2/N_1$ ... Transformer equation
- $\epsilon(t) = \epsilon_0(2\pi f)\cos(2\pi f t)$ ... Variation of induced voltage as a function of time and frequency.

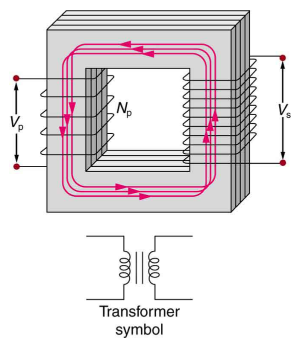

Figure 1: A basic diagram of a transformer with transmit and receive coils.

2 Faraday's Law, Transformers, and Scaling Properties

1. Consider Fig. 1, which depicts a *transformer.* There are two solenoids, the *transmit* and *receive* coils. Using Faraday's law at constant frequency, convince yourself that

$$\frac{\epsilon_{TX}}{\epsilon_{RX}} = \frac{N_{TX}}{N_{RX}} \tag{1}$$

2. A battery charger meant for a series connection of ten nickel-cadmium batteries (total emf of 12.5 V DC) needs to have a 15.0 V output to charge the batteries. It uses a step-down transformer with a 200-loop primary and a 120 V input. (a) How many loops should there be in the secondary coil? (b) If the input current is 16.0 A, what is the output current?

3. Suppose Fig. 1 represents our Faraday's Law lab activity (using an iron core to connect the flux rather than overlapping the coils). (a) If we observe $\epsilon_{RX}(t) = 5.0\cos(2\pi f t)$ Volts, with $f = 1$ kHz, what will $\epsilon_{RX}(t)$ be at $f = 5$ kHz? (b) What is the period of $\epsilon_{RX}(t)$ when $f = 5$ kHz?