Electric Transformers

Review the Textbook on AC Circuits, and Transformers.

- Phys 1402: Serway/Vuille: Section. 21.1, and 21.7.
- Phys 2426: Serway/Jewett: Section. 33.1, 33.2, and 33.8.

AC voltages can to be measured in "RMS" or as "peak" (aka "max") values. The RMS voltage is smaller than the peak voltage by a factor of $\sqrt{2}$.

$$V_{\rm RMS} = V_{\rm max}/\sqrt{2}$$

A transformer scales voltages by using two coils that share their magnetic fields. There are different numbers of loops of wire (called turns) in each of the coils. The primary receives energy from the power source, and the secondary gives energy to the device. Ideally, the rate of energy coming in must equal the rate going out; therefore

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} \qquad \qquad \frac{I_s}{I_p} = \frac{N_p}{N_s}$$

- 1. A wall outlet provides an RMS voltage of 120 V. What is the peak voltage? (170 V)
- A transformer is to be designed to increase the 30 kV RMS output of a generator to the transmission-line RMS voltage of 345 kV. If the primary winding has 80 turns, how many turns must the secondary have? (920 turns)
- A step-up transformer has an input voltage of 110 V (rms). There are 100 turns on the primary and 1500 on the secondary. What is the RMS output voltage? (1650 V)
- **4.** What kind of transformer is in Figure 1? Justify your answer. (Step-down; number of turns in the secondary coil is less than in the primary coil)
- In Figure 1, the secondary coil has 50 turns, and the primary has 200 turns. If an RMS voltage of 440 V is placed across the primary, what is the RMS voltage of the secondary? (110 V)
- 6. What is the RMS current in the secondary coil of the transformer in Figure 1 when the load resistance is 7.00 Ω ? (15.7 A)



Figure 1. A Transformer hooked up to a 7 Ω resistor used in Questions 4 and 5.

7. Assuming that a transformer shown in Figure 1 is an ideal transformer, compare the power input of the primary coil with the power output of the secondary coil. Calculate the current in the primary. (The powers are equal; 3.9 A)