Homework Problem #050
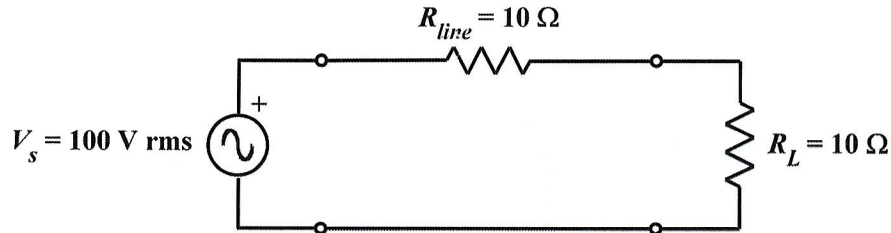
A resistive load is connected to a voltage source by a transmission line having 10Ω resistance as shown below:

a. Find the average power delivered by the source.
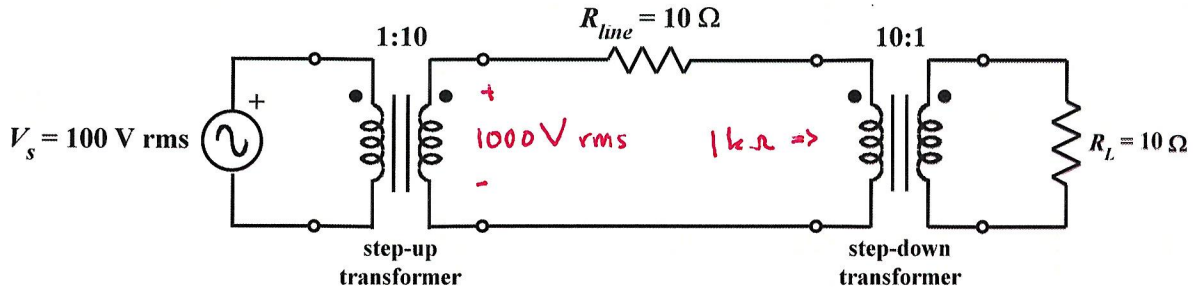
$$P = \frac{(100)^2}{20} = 500 \text{ W}$$

b. Find the average power dissipated in the line resistance.

$$P = 250 \text{ W}$$

c. Find the average power delivered to the load.

$$P = 250 \text{ W}$$

Now the system is modified by adding two transformers, one to step up the voltage at the sending end, and another to step it back down at the load, as shown below:

For this modified system:

d. Find the average power delivered by the source.

$$P = \frac{(100)^2}{10.1} \approx 990 \text{ W}$$

e. Find the average power dissipated in the line resistance.

$$P = \left(\frac{1000}{1010}\right)^2 (10\,\Omega) \approx 9.8 \text{ W}$$

f. Find the average power delivered to the load.

$$P = \left(10 \cdot \frac{1000}{1010}\right)^2 (10\,\Omega) \approx 980 \text{ W}$$

If efficiency is defined as the ratio of "power delivered to the load" to "power supplied by the source," expressed as a percentage:

g. Determine the efficiency of the original system.

$$\frac{250}{500} \times 100\% = 50\%$$

h. Determine the efficiency of the modified system.

$$\frac{980}{990} \times 100\% \approx 99\%$$

i. In terms of efficiency, which system is better?

The modified system is much better (99% vs. 50%)