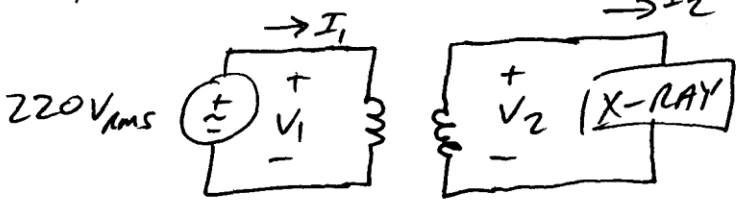
An ideal transformer was designed to run an X-ray machine at a voltage of 50 kV_{rms} and 270 mA_{rms} current. The transformer operates from a 220-Vrms power supply. However, the resistance in the wires connecting the power supply to the transformer was initially ignored. Upon installation, it was realized that the supply wires have a total resistance of 0.6 Ω. By how much must the supply voltage be increased in order to maintain the same operating parameters at the transformer output?

Ideal w/out wire resistance



$V_2 = 50\,kV_{rms}$

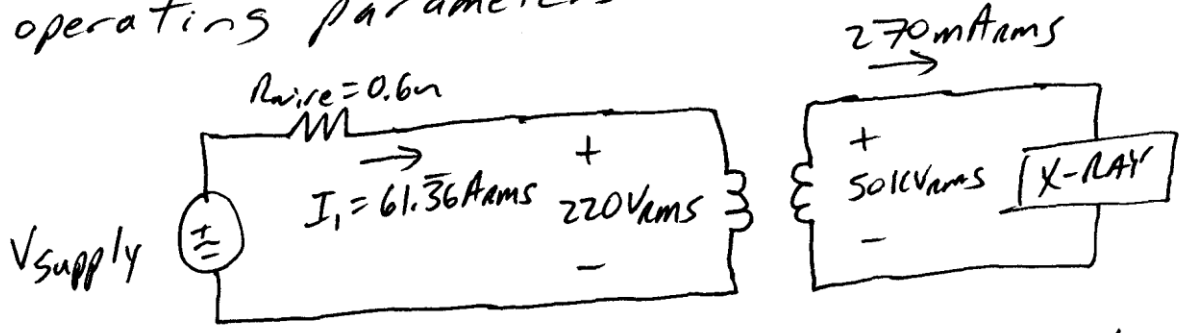
$I_2 = 270\,mA_{rms}$

From Dr. Whites notes (Lecture 9 Ideal Transformer)

$$\frac{V_1(t)}{V_2(t)} = \frac{N_1}{N_2} = \frac{220}{50\times10^3} = 4.4\times10^{-3}$$

$$\frac{I_1(t)}{I_2(t)} = \frac{N_2}{N_1} \Rightarrow I_1 = \frac{1}{4.4\times10^{-3}}(0.27) = 61.\overline{36}\,A_{rms}$$

Adding wire resistance and maintains same operating parameters



Apply KVL around primary/supply side

$$-V_{supply} + 61.\overline{36}(0.6) + 220 = 0$$

$$V_{supply} = 256.\overline{81}\,V_{rms}$$

$$Increase = V_{supply} - 220 = \underline{36.\overline{81}\,V_{rms}}$$