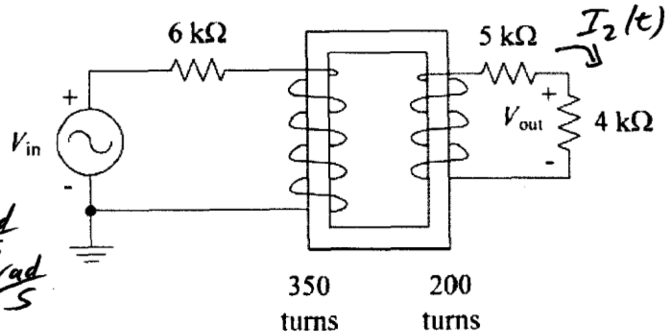
A voltage source $V_{in}(t) = 5 + 5\cos(2\pi ft)$ V is connected to an ideal transformer as shown in the figure below. If $f = 40$ kHz, find the output voltage $V_{out}(t)$.

$\omega = 2\pi f$
$= 2\pi(40\times10^3)$
$= 80\pi\times10^3 \frac{rad}{s}$
$= 251{,}327.4 \frac{rad}{s}$



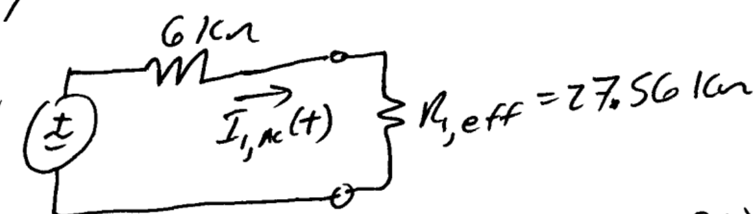
⇒ Ignore DC component of $V_{in}(t)$ as it will NOT couple to the secondary side of the transformer

⇒ For the AC component, the primary side 'sees' an effective input resistance (see Dr. Whites notes, Lecture 9 Ideal Transformer) of

$$R_{1,eff} = \left(\frac{N_1}{N_2}\right)^2 R_L = \left(\frac{350}{200}\right)^2 (5000 + 4000)$$
$$= 27562.5\,\Omega$$

Equiv. Primary Circuit (AC ONLY)

$5\cos(2\pi ft)$ V



$$I_{1,AC}(t) = \frac{5\cos(2\pi ft)}{6000 + 27562.5} = 1.49\times10^{-4}\cos(2\pi ft)\text{ A}$$

Per ideal transformer current relationship,

$$\frac{I_1(t)}{I_2(t)} = \frac{N_2}{N_1} \Rightarrow I_2(t) = \frac{N_1}{N_2} I_1(t) = \frac{350}{200}\left(1.49\times10^{-4}\cos(\ )\right)$$

$$V_{out}(t) = I_2(t)\,4000 = 2.607\times10^{-4}\cos(\ )\,4000$$

$$\underline{V_{out}(t) = 1.0428\cos(251{,}327.4t)\text{ V}}$$