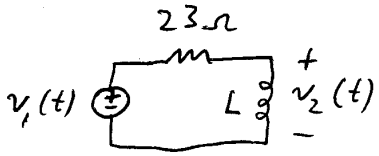
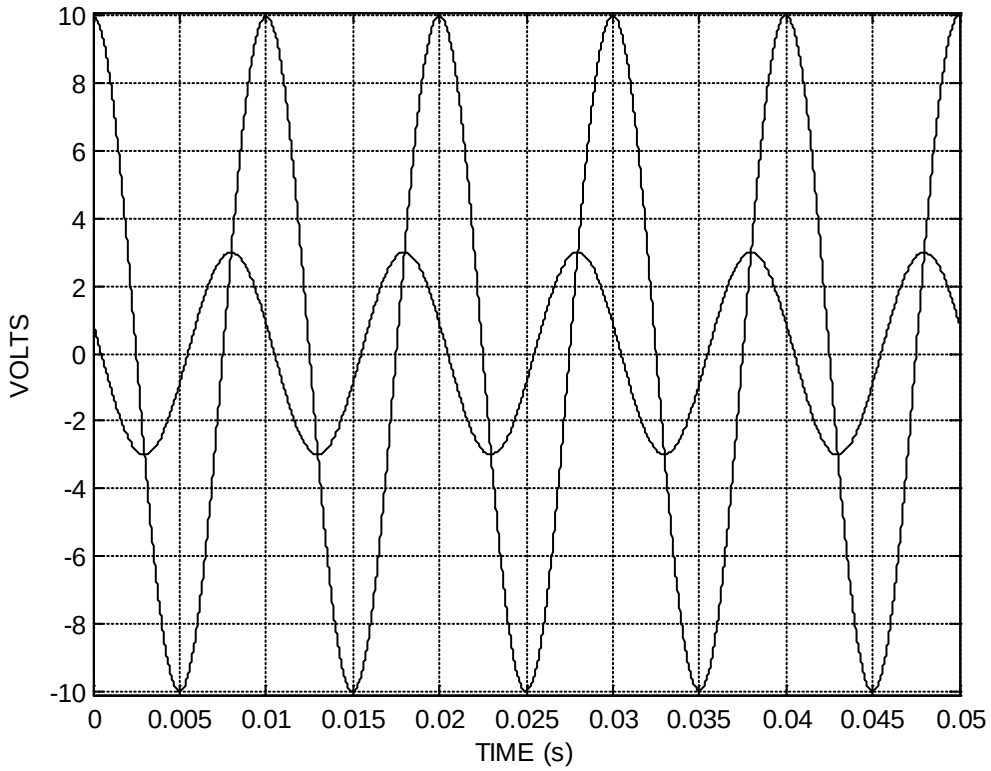
Homework 5: Supplemental Problems

Problem 1:

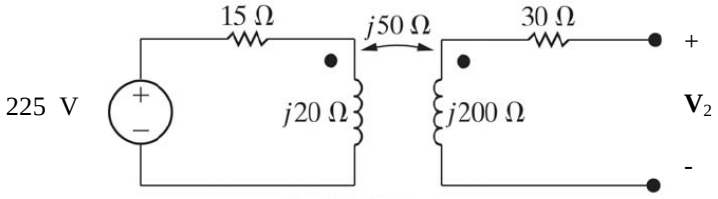
The voltage waveforms for $v_1(t)$ and $v_2(t)$ in the circuit to the right are shown below in sinusoidal steady-state.
Please estimate the value of the inductance, L.





Problem 2: Please answer the following for the sinusoidal steady-state circuit shown below

(a) Find the voltage phasor $\mathbf{V}_2$ in the *linear* transformer circuit and express it in polar form (magnitude and angle).



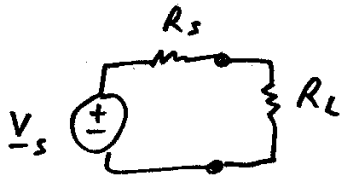
(b) Replace the linear transformer by an *ideal* transformer with turns ratio 1:*a* where $a = \sqrt{\frac{\omega L_2}{\omega L_1}} = \sqrt{\frac{200}{20}} = \sqrt{10}$. Repeat part (a) and find the voltage phasor $\mathbf{V}_2$.

Compare your answers. What is the value of $k = \frac{M}{\sqrt{L_1 L_2}}$? How accurate is the ideal transformer model for the circuit in part (a) with open-circuit load?

Problem 3:

The voltage source in the circuit below is sinusoidal with $v_s(t) = 10 \cdot \sqrt{2} \cos(500t)$ V
so the RMS phasor is $\mathbf{V}_s = 10 \angle 0^\circ$ V .

(a) Suppose the load resistor R_L is connected directly to the source, without the transformers. What is the average power absorbed by R_L ?

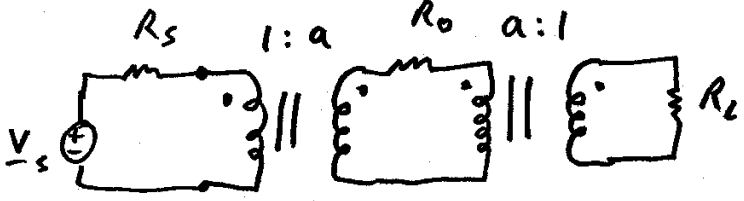


(b) Now suppose the transformers are connected between the source and R_L . with $R_0 = 100$ ohms and a in the range from 1 to 10.

- What value of a will maximize the average power absorbed by R_L ?
- What is the average power absorbed by R_L for this value of a ?

Hint: Be careful, and think before applying the formulas!

$\mathbf{V}_s = 10 \angle 0^\circ$ V (rms)
$R_s = 10\ \Omega$
$R_L = 20\ \Omega$
$R_0 = 100\ \Omega$
$1 \le a \le 10$



Problem 4:

The following ideal transformer circuit is shown in the frequency domain for sinusoidal steady-state conditions. The voltage source phasor is 10 V (peak amplitude). Find the phasor of the **voltage** across the 2 ohm resistor, $\mathbf{V}_L$, and the phasor of the **current** through the 2 ohm resistor. Be sure to indicate the **direction** of your current on the circuit diagram.