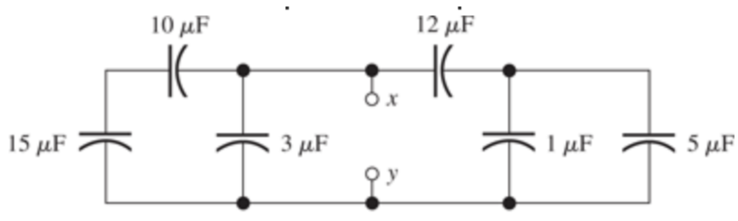
ECE 100 (Spring 2021) - Homework #3

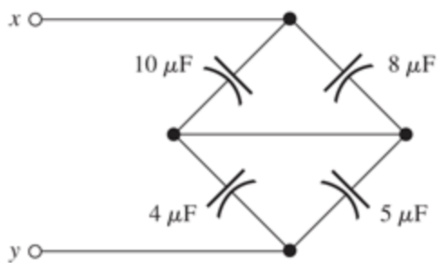
Due Date: Sunday, April 18th @ 11:59pm PDT
Recommended Readings: 2.6-2.7, 4.1-4.4

Problem 1 (10 points)

P3.25. Find the equivalent capacitance between terminals *x* and *y* for each of the circuits shown in **Figure P3.25**.



(a)

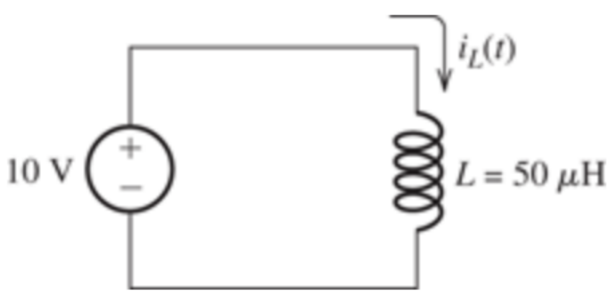


(b)

Problem 2 (10 points)

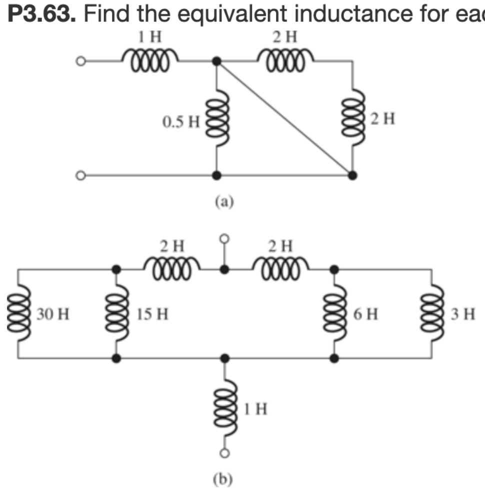
A constant voltage of 10V is applied to a 50-μH inductance as shown in the figure below. The current in the inductance at t=0 is $i_L(t = 0) = -100mA$.

(a) At what time t_x does the current reach +100mA?
(b) Why is this circuit unrealistic?



Problem 3 (10 points)

P3.63. Find the equivalent inductance for each of the series and parallel combinations shown in **Figure P3.63**.



Problem 4 (10 points)

***P3.76.**

a. Derive an expression for the equivalent inductance for the circuit shown in **Figure P3.76**.

b. Repeat if the dot for L_2 is moved to the bottom end.

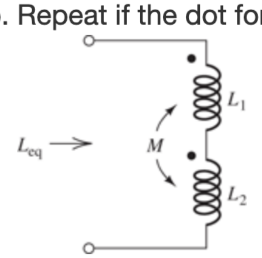


Figure P3.76

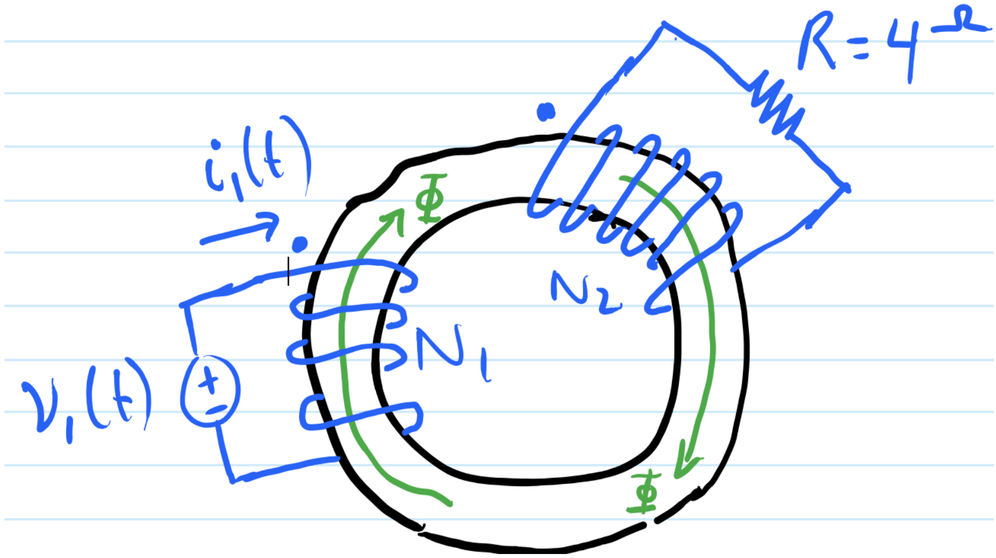
Problem 5 (15 points)

The figure below shows an ideal transformer with two coils. A circuit has been built around the transformer using a voltage source with unknown value (v_1) and a resistor (R=4Ω). The flux in the core (ϕ) was observed to be $\Phi = \Phi_0 \times sin(\omega t)\ [Webers]$ where Φ_0 and ω are known constants and t is provided in seconds. Using this information, find the following quantities:

(a) $v_1(t)$

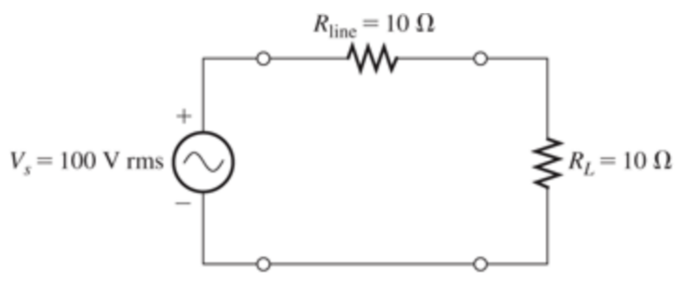
(b) $i_1(t)$

(c) $v_1(t)/i_1(t)$

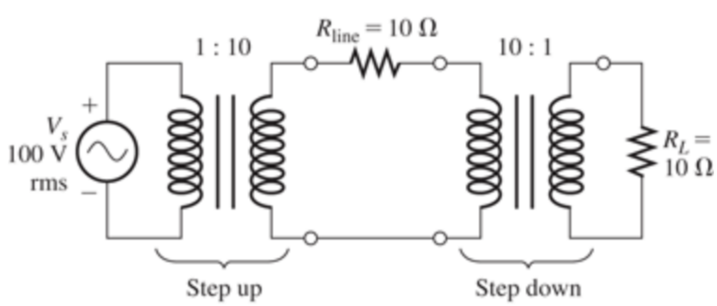


Problem 6 (15 points)

P14.62. A voltage source V_s is to be connected to a resistive load $R_L = 10\ \Omega$ by a transmission line having a resistance $R_{\text{line}} = 10\ \Omega$, as shown in **Figure P14.62**. In part (a) of the figure, no transformers are used. In part (b) of the figure, one transformer is used to step up the source voltage at the sending end of the line, and another transformer is used to step the voltage back down at the load. For each case, determine the power delivered by the source; the power dissipated in the line resistance; the power delivered to the load; and the efficiency, defined as the power delivered to the load as a percentage of the source power.



(a)



(b)

Hint: "V_s = 100V rms" is a sinusoidal waveform (e.g. $V_s(t) = 100V_{rms} \times sin(\omega t)$). In this problem, you are solving simply for average power which is $P_{average} = I_{rms} \times V_{rms}$.

Not needed to solve the problem but in case you are curious...
The RMS voltage differs from the peak-to-peak voltage of a waveform. It is utilized to calculate average power instead of peak power. If A is the peak voltage of the sinusoidal v(t) waveform then the rms voltage would be $A/\sqrt{2}$.

$v(t) = A \times sin(\omega t)\ [V] \rightarrow v_{rms}(t) = \frac{A}{\sqrt{2}} sin(\omega t)\ [V]$.

This is because:

$P_{average} = (I^2(t) \times R)_{avg} = (I^2(t))_{avg} \times R = I_{rms}^{\ 2} \times R$

$P_{average} = (V^2(t) / R)_{avg} = (V^2(t))_{avg} / R = V^2_{rms} / R$

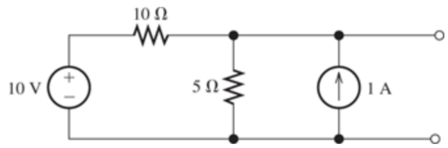
If $V(t) = V_o \times sin(\omega t)\ [V]$, then $P_{average} = \frac{1}{T}\int_0^T P(t)\, dt = \frac{(V_o)^2}{R}\int_0^T sin^2(\omega t)\, dt = \frac{(V_o)^2}{2} \times \frac{1}{R}$.

This implies that the rms voltage is $V_{o,rms} = V_o/\sqrt{2}$ *and* $P_{average}$ *can be solved simply as:*

$$P_{average} = \frac{(V_{o,rms})^2}{R} = \frac{1}{2}\frac{(V_o)^2}{R}$$

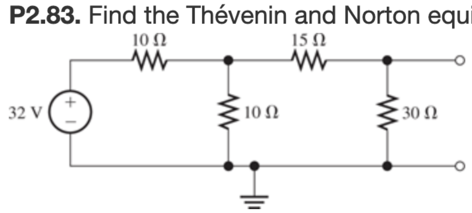
Problem 7 (10 points)

***P2.80.** Find the Thévenin and Norton equivalent circuits for the two-terminal circuit shown in **Figure P2.80**.



Problem 8 (10 points)

P2.83. Find the Thévenin and Norton equivalent circuits for the two-terminal circuit shown in **Figure P2.83**.



Problem 9 (10 points)

***P4.3.** The initial voltage across the capacitor shown in **Figure P4.3** is $v_C(0+) = -10$ V. Find an expression for the voltage across the capacitor as a function of time. Also, determine the time t_0 at which the voltage crosses zero.