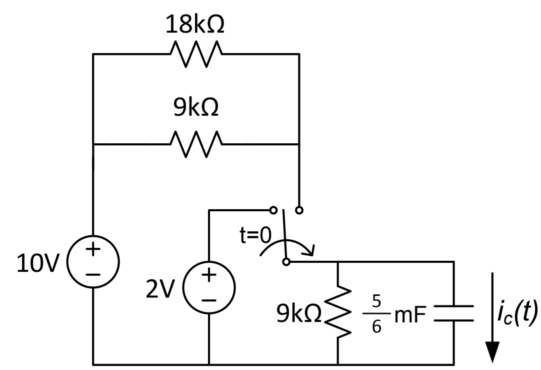
As usual, you should prepare for the final exam by using the student study guide to identify weak areas, and then strengthen those weak areas by attempting to solve, on your own and without looking at the solutions, corresponding homework and practice problems. After you feel confident with your preparation, take this practice exam to test your preparedness and to identify any remaining weak areas. Do not prepare for the exam by memorizing the solution methods for these particular problems; their topical areas are the same as on the final and match those listed on the student study guide, but the specific problems bear no resemblance whatsoever to the problems on the final. Use the student study guide first, then your homework and collaborative problems, and then you will be prepared. Email me if you cannot understand a particular step in the solutions from any EE223 material, or if you do not understand why a step you took is incorrect (which even more valuable to know!)

Problem 1: First-Order Circuits



a) Find $i_c(t)$ for *all* time. Hint: nice fractions.

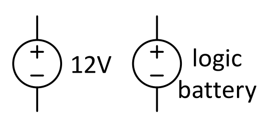
b) Find and sketch the voltage across the capacitor, $v_c(t)$ over five time constants τ. Label important values on both the v and t axes.

Problem 2: Laboratory-Based Design Problem

Your senior design robot is having problems. It works perfectly sometimes, but after about an hour of testing it starts shaking and acting as if it is having seizures. A few of you realize the problem is related to the logic battery pack powering the microcontroller; when it discharges below 5V it can no longer provide the power required by the microcontroller, which then behaves erratically. Help fix the problem by designing a circuit that lights a very bright warning LED when the logic battery pack drops below 5V. You may use the following components:

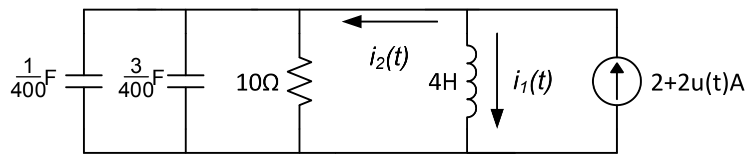
- 12V regulated voltage source devoted to your circuit (its voltage does not change)
- The logic battery pack output that is 6V when fully charged
- A bright red warning LED that drops 2.2V and requires 20mA
- A comparator
- Any number of resistors of any value

The start of the circuit is shown to the right:



Problem 3: Second-Order Circuits

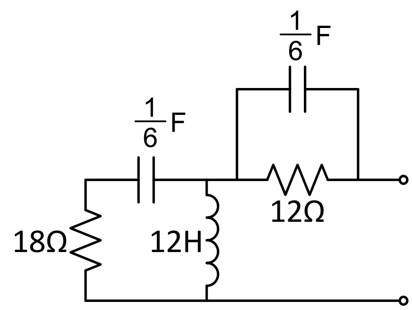
a) Given the circuit shown to the right, find $i_1(t)$, for t>0:
Hint: all integers in answer



b) Find $i_2(t)$, for t>0:
Hint: all integers in answer

Problem 4: Phasors

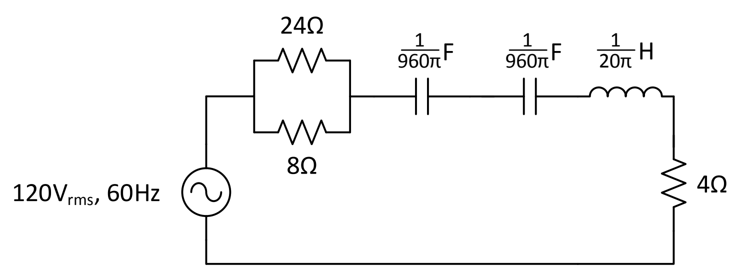
a) Given the circuit shown to the right, find the complex impedance, in rectangular form, between the circled terminals for a frequency of ω= ½ rad/s.
Hint: imaginary part is between 0.5 and 1Ω.



b) Find two components that, when connected in series, form the Thevenin equivalent to the entire circuit at that frequency in part a) of ω= ½ rad/s.
Hint: Inductor is a bit over 1H in size

Problem 5: Complex Power

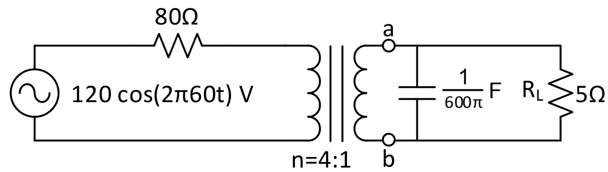
a) Find the real P and complex S power delivered to the 4Ω resistor.
Hint: P is a bit less than 300W.



b) Determine the power factor seen by the source and correct it to 1 by using a capacitor in series with the source. Hint: pf has a sqrt(2) in its answer.

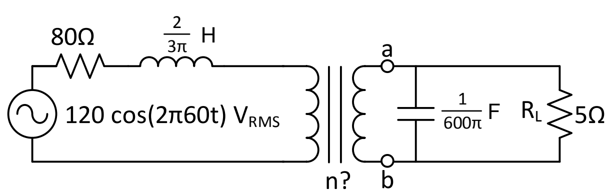
Problem 6: Transformers

a) Circuit II cadets notice some dislodged ceiling tiles in the lab and upon investigating discover the circuit to the right hidden above the ceiling, right next to the First Class beer stash. The power source at the left indicates where it is plugged into a power outlet. The circuit to the right of a-b represents a solid-state Peltier cooling junction used to ice the beer. Suspecting foul play given the irrational choice of resistors, they calculate the average power being absorbed by the load to the right of the terminals a-b (i.e. the load is both the capacitor and the resistor). Recall powerline frequency in the U.S. is 60Hz.



b) How much of the average power you calculated in part a) is being absorbed by the resistor, and how much is being absorbed by the capacitor?

c) The next day they discover the Seniors are trying to make the Peltier junctions work more efficiently by adding an inductor as shown below. Alas, they have failed to design the optimal transformer because they forgot their Circuits II skills. Help them find the correct transformer ratio *n* to optimize power delivery to the load. (Hint: it won't be a whole number. That's OK; you can design a, say, n=0.123 ratio transformer by noting 0.123 = 123/1000, so the primary has 123 windings for every 1000 in the secondary).



d) To show off, the Circuits II students leave a note listing both the reactive and complex power dissipated by the modified circuit's load (i.e. the capacitor and 5Ω resistor). What did the note say? Include units.