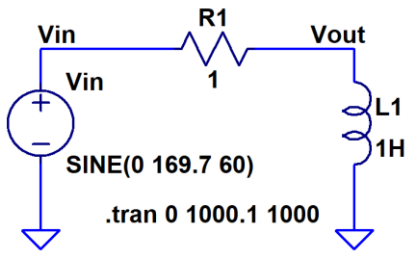
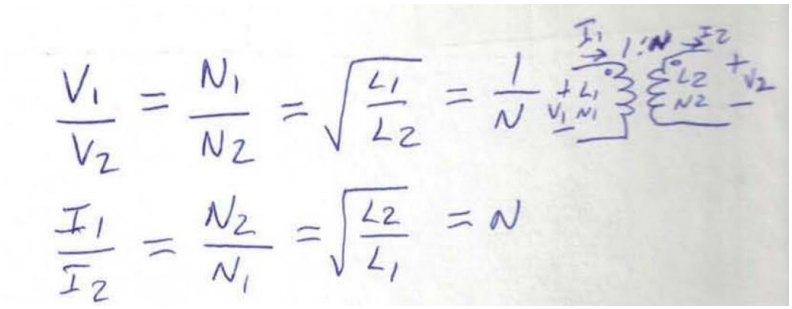
H.W. #1 EE 442/ECG 642 Fall 2022

Show your work for credit and follow the homework guidelines.

1. Are neutral and ground ever connected together? Are they connected together at a power outlet or in a device connected to a power outlet? Why or why not? Google, and show, an image of a ground conductor connecting to the rebar in a building foundation at a breaker box. (4 points)
2. Is one, two, or three phase power supplied to most residences in the United States? What is the voltage that is supplied in a common wall outlet between line (aka hot or phase) and neutral, line and ground, neutral and ground? What is the center tap of the transformer that supplies energy to a residence in the United States connected to in the breaker box? (3 points)
3. Estimate, using hand calculations, the current flowing in the following circuit. Verify your answer using LTspice. (3 points)

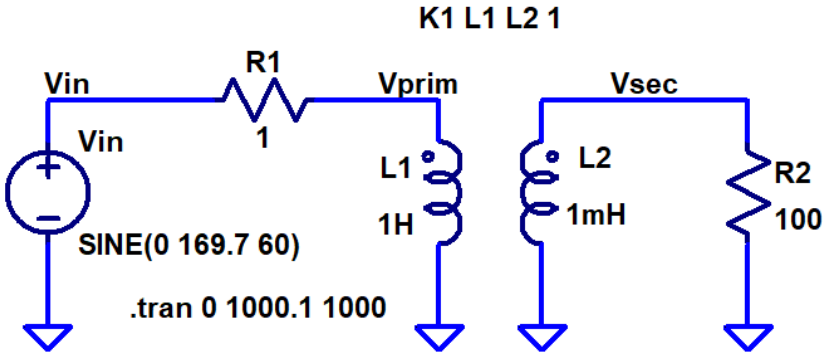


4. In a transformer the primary inductance may be made large so that the following equations can be used to describe the operation of the transformer. In other words, there are two components to the current in L1, a current due to driving the inductance of L1 itself (called a ***magnetizing current***) and a current due to the magnetic coupling (mutual inductance) from L1 to L2 when L2 is connected to a load. If the magnetizing current is small then the following equations may be used.



   a) For the circuit below, estimate the current flowing in the primary of the transformer with no load (R2 = open). In other words, estimate the magnetizing current flowing in the magnetizing inductance (use LTspice to verify, 2 points).
   b) Next, use the above equations to estimate the current in the load, and thus the secondary of the transformer, with R2 connected and equal to 100 ohms (use LTspice to verify, 2 points).

c) Then estimate the current flowing in the primary of the inductor knowing it will be related to the sum of the previous two calculations (use LTspice to verify, 4 points).
d) Finally, estimate how much you have to increase both L1 and L2 (keeping the ratio the same) so that the magnetizing current can be neglected (assume the magnetizing current is < 1% of the primary transformer current) so that we can use the above equations. (use LTspice to verify, 2 points)



5. Sketch a half-wave bridge rectifier, a full-wave bridge rectifier, and a full-wave rectifier using a center-tap transformer. Show where the load and filter capacitor would be connected in each topology. (1 point)