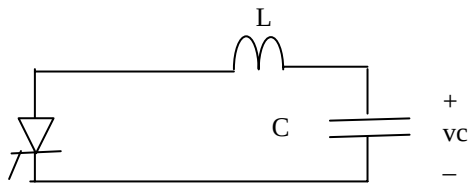
EE432/537 Power Electronics Homework #1 Circuit Analysis 1 Due Tuesday 2/6

Collaboration encouraged, but turn in your own work.

1. The Flipper (Resonant Pole)

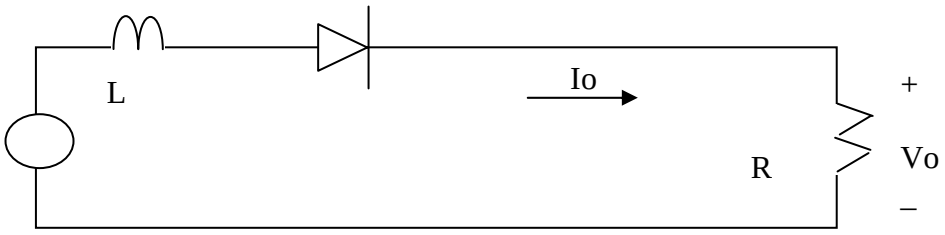


In the circuit above, initially, the capacitor is charged to E volts with the polarity shown and the SCR is off. At time t=0 the SCR is turned on by a positive pulse of gate current. Determine the circuit response and final value of capacitor voltage. (Ans: Final value of capacitor voltage = -E)

2. Resistance is unavoidable in conventional power electronics, and reduces both efficiency and circuit performance. Rework the voltage doubler circuit with resistance included. Assume E=10 V, R=0.001 ohm, L = 1 mH and C = 1 uF.

   Does the voltage double?
   (Final voltage is larger than E but not double)

3. The single phase, full wave rectifier is shown below, except we have added the inductance of the source. Because of this inductance, the current will not be zero when input voltage goes to zero. It appears that the diode will continue to conduct for some time past the negative-going zero crossing of the voltage.
   a. Develop the differential equation and its solution. From the solution determine how long the diode will conduct (You will need trial and error) Sketch output voltage and current waveforms for 3 cycles.
   b. Determine the average output voltage. Compare with the average output voltage of the rectifier when inductance is zero. What is the effect of the inductance?

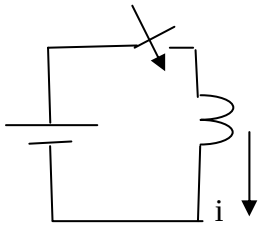


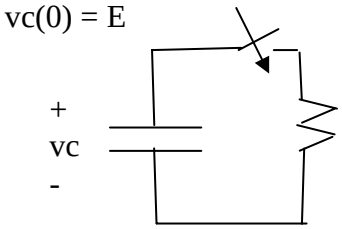
Partial Ans:

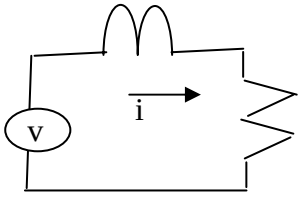
$$i(t) = [\frac{V\max}{\sqrt{R^2 + \omega^2 L^2}}][\sin(\omega t - \phi) + \sin(\varphi)e^{-tR/L}] \qquad where \quad \varphi = \tan^{-1}(\omega L / R)$$

4. In problems 1 -3 I hope you carefully developed differential equations and solved the. In the following scribbling differential equations will help, but I really don't want you to solve them Use your intuition instead.

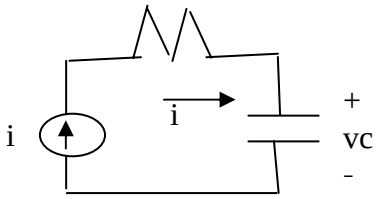
   Make approximate sketches for the quantity listed in the circuits below.



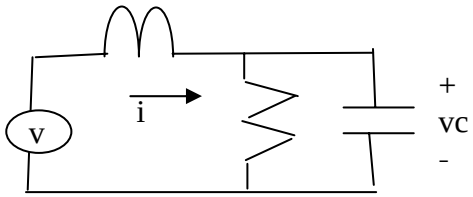




v is a square wave voltage



i is a square wave current



v is a square wave voltage

5. For the single-phase, square wave inverter assume a lagging ac load as described in the notes. For one complete cycle of ac voltage and current
   a. Identify the oeriods of time when each switch and diode conducts.
   b. Sketch the waveform of current drawn from the dc supply.