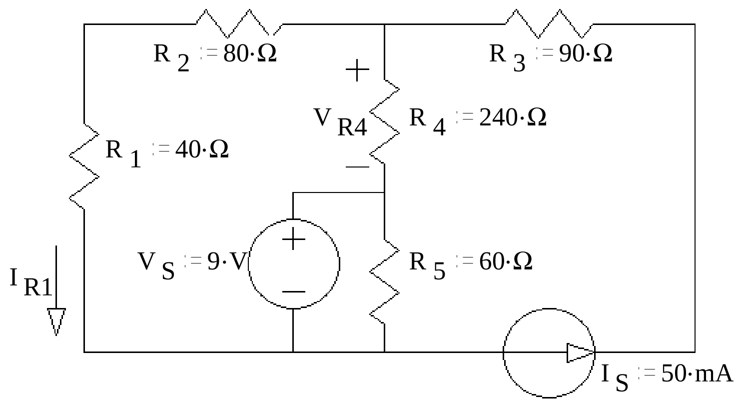
ECE 2210 Final given: Fall 20

1. (22 pts) Use nodal analysis to find the voltage across R_4 (V_{R4}) and the current through R_1 (I_{R1}).

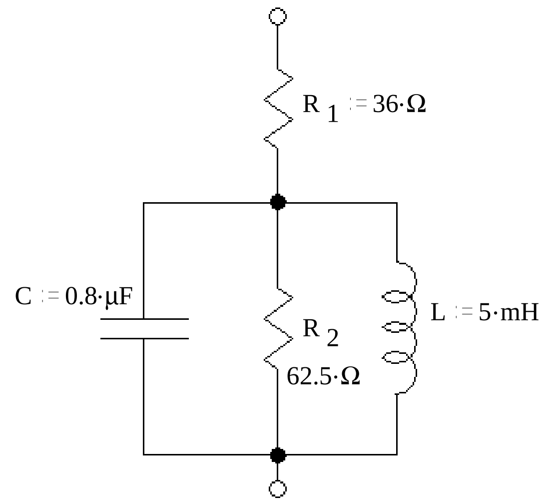
   You **MUST** show all the steps of nodal analysis work to get credit, including drawing appropriate symbols and labels on the circuit shown.



2. (20 pts) Find $\mathbf{Z_{eq}}$ in simple polar form (give me numbers).

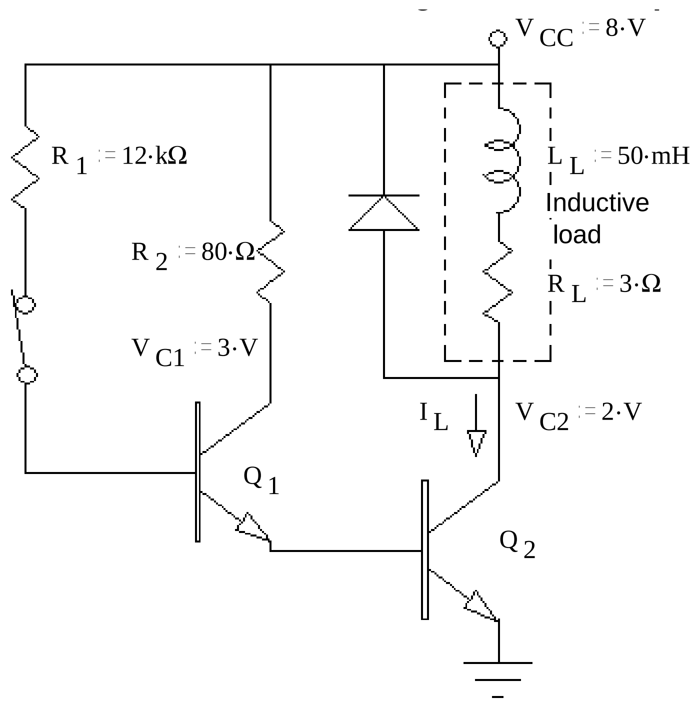
   You must show work and intermediate results.

   f := 1.59155·kHz



3. (36 pts) A couple of transistors are used to control the current flow through an inductive load.

a) You measure the voltage at each collector (referenced to ground) as shown on the drawing. Find the power dissipated by transistor Q_2 .
P_{Q2} = ?



b) Find the β of transistor Q_2 . β_2 = ?

You may assume that the emitter current of Q_1 is approximately equal to the collector current of Q_1.

c) Find the β of transistor Q_1 . β_1 = ?

d) Find the minimum β for transistor Q_1 to be in saturation. β_{1min} = ?

You replace Q_1 with a different transistor so that $\beta_1 > \beta_{1min}$. Use this from now on.

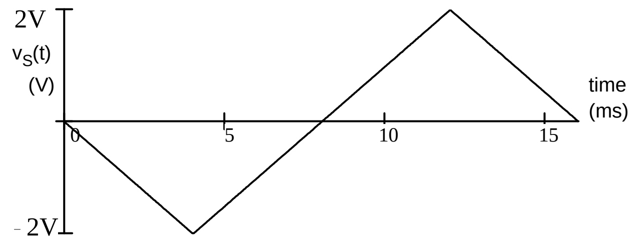
e) Find the new load current. I_L = ? Be sure to explictly check any assumption you make about the state of Q_2.

f) Find the power dissipated in transistor Q_2 . P_{Q2} = ?

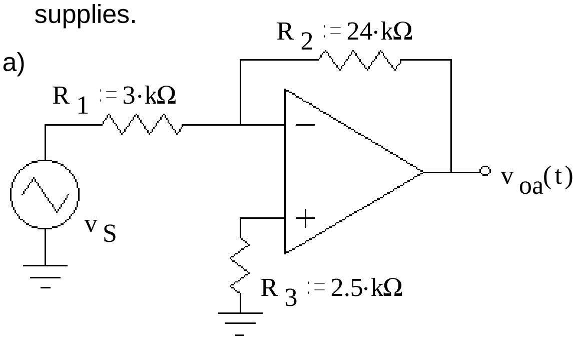
g) The diode in this circuit conducts a significant current: (circle one)
A) never.
B) when the switch first closes.
C) whenever the switch is closed.
D) always.
E) when the switch first opens.
F) whenever the switch is open.

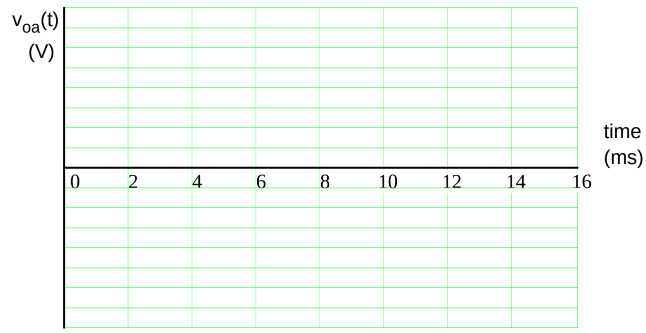
h) What is the maximum diode current you expect when the switch is cycled. (Answer 0 if it never conducts.)

4. (32 pts) The same input signal (at right) is connected to several op-amp circuits below. Sketch the output waveform for each circuit. Clearly label important voltage levels on each output. If I can't easily make out what your peak values are, I'll assume you don't know. Don't forget to show inversions. All op-amps are powered by ± 15 V power supplies.

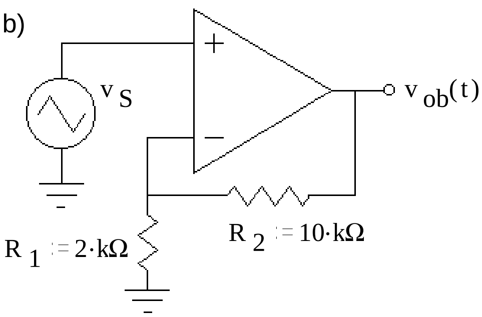


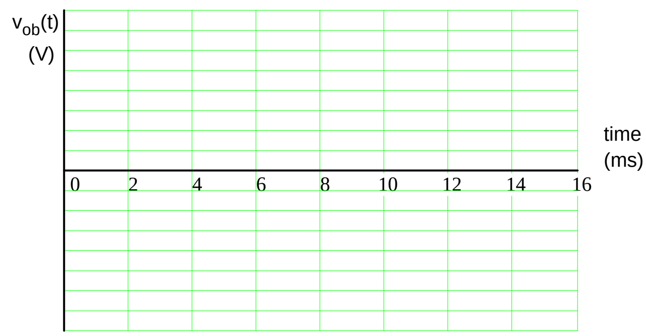
a)



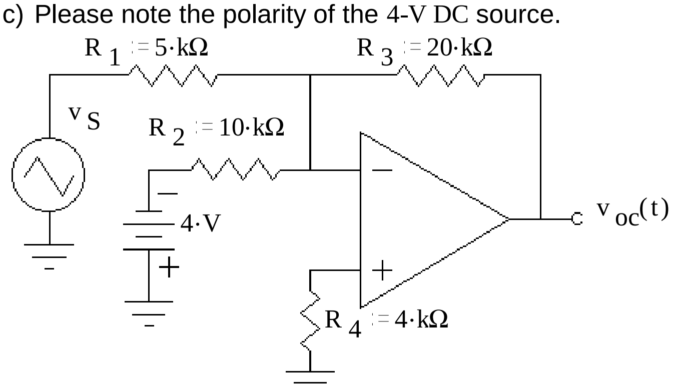


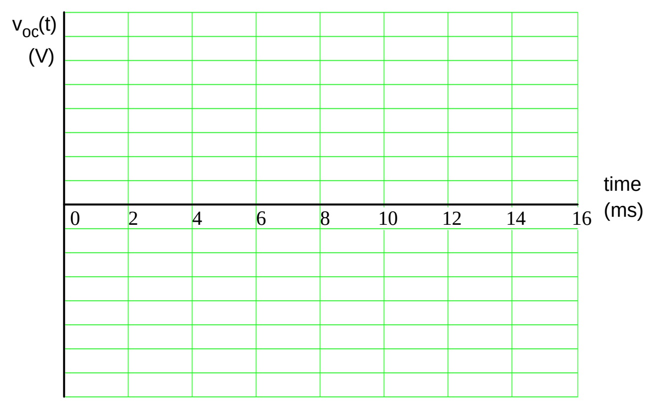
b)



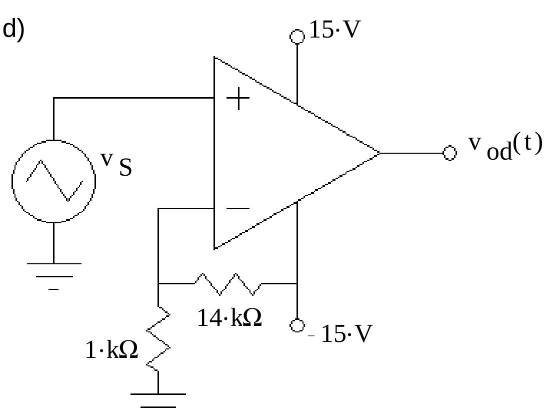


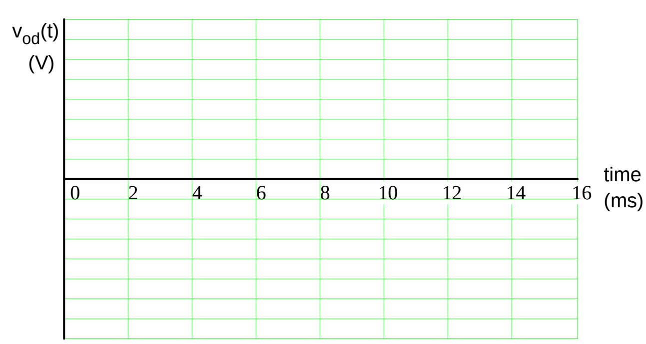
c) Please note the polarity of the 4-V DC source.



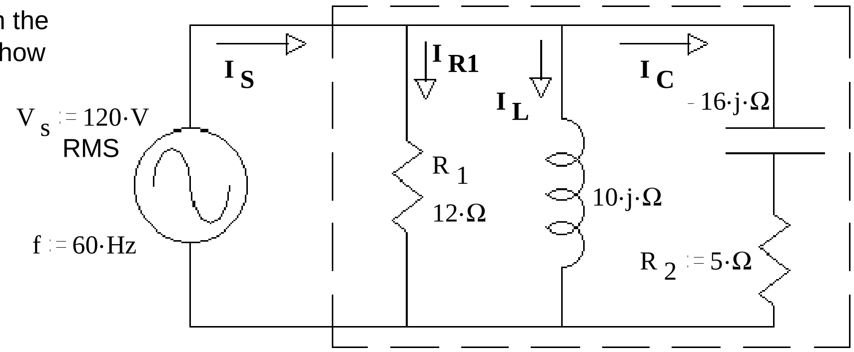


d)





5. (42 pts) the Cs, L, & R together are the load in the circuit shown. Find the following: Be sure to show the correct units for each value.



load in dashed box

a) The magnitudes of these 3 currents.
$|\mathbf{I}_{R1}|$ = ? $|\mathbf{I}_{L}|$ = ? $|\mathbf{I}_{C}|$ = ?

b) The real power. P = ?

c) The reactive power. Q = ?

d) The complex power. **S** = ?

e) The apparent power. |**S**| = ?

f) The power factor. pf = ?

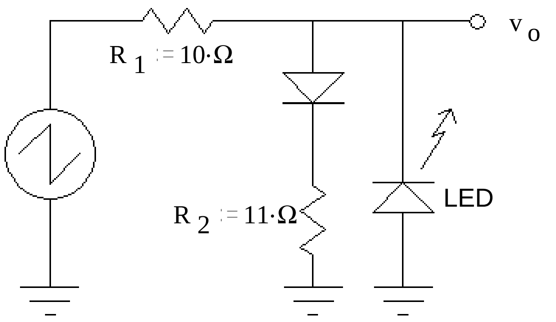
g) The power factor is: i) leading ii) lagging (circle one)

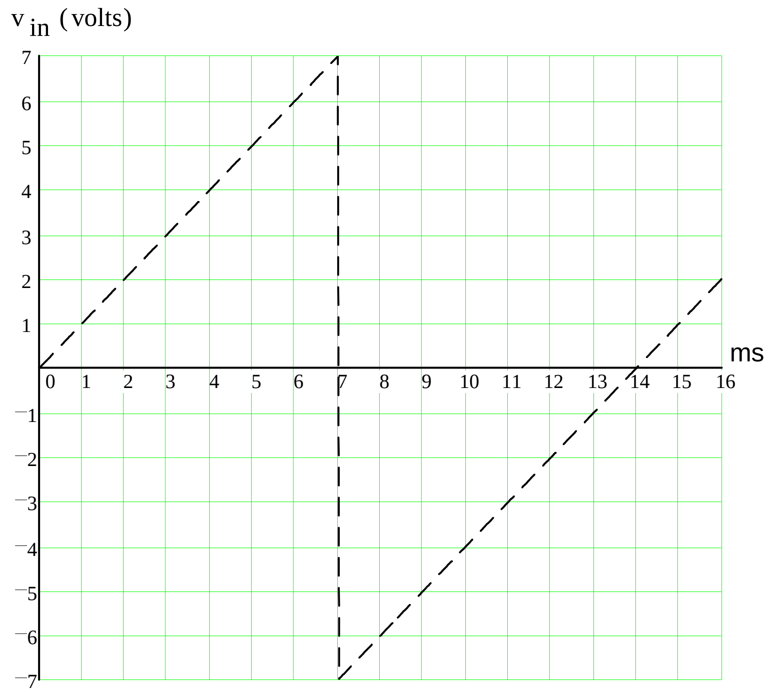
h) The magnitude of the source current. $|\mathbf{I}_{S}|$ = ?

i) Remove the inductor and replace it with a new component which makes the power factor the entire load perfect (make pf = 1). Determine the type and value of this component.

j) Find the new magnitude of the source current. $|\mathbf{I}_{S}|$ = ?

6. (24 pts) A voltage waveform (dotted line) is applied to the circuit shown. <u>Accurately</u> draw the output waveform (v_o) you expect to see. Label important times **<u>and</u>** voltage levels.





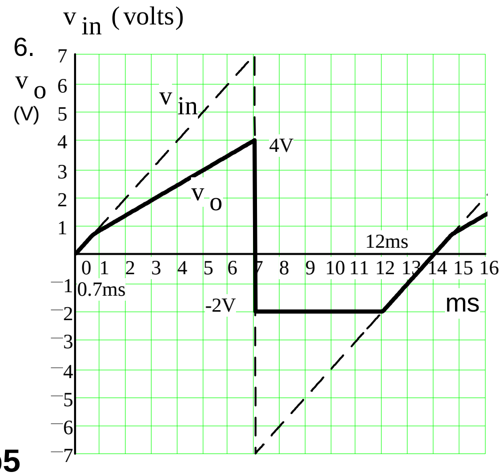
Answers

1. -2·V 58.3·mA 2. 81.7Ω / -21.5°

3. a) 4·W b) 32 c) 113.6
   d) 161.4 e) 2.6·A f) 0.52·W
   g) E) h) 2.6·A

5. a) 10·A 12·A 7.16·A b) 1456·W
   c) 620·VAR d) (1456 + 620·j)·VA
   e) 1583·VA f) 0.92 g) ii)
   h) 13.2·A i) Replace inductor with a 46.6mH inductor.
   j) 12.14·A

6.



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