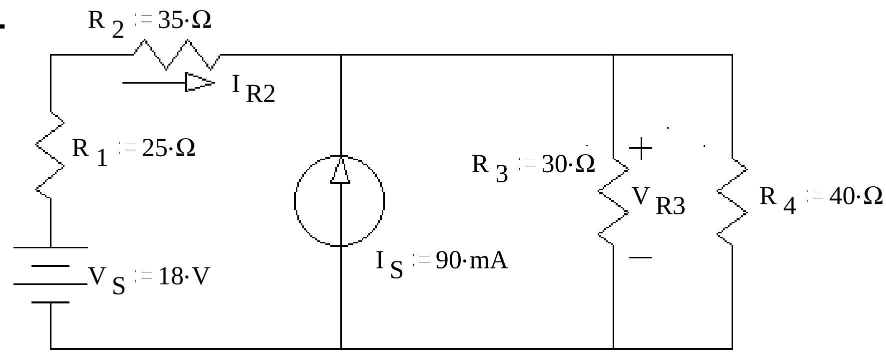
ECE 2210 Final give Spring 21

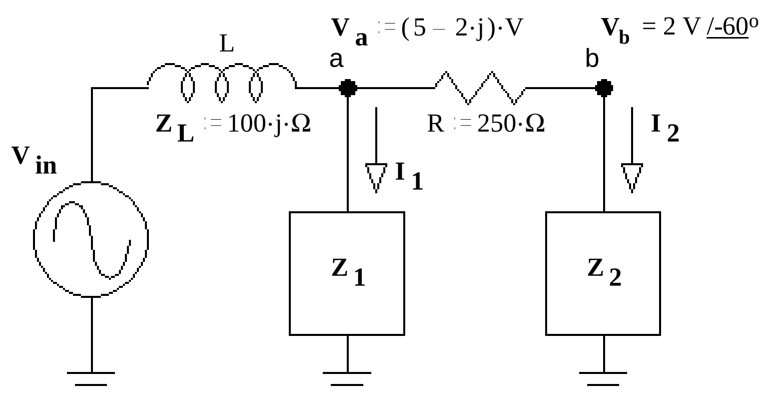
1. (24 pts) Use nodal analysis to find the voltage V_{R3} and the current I_{R2} .

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



2. (34 pts) $\mathbf{V_a}$ is the nodal voltage at node a and $\mathbf{V_b}$ is the nodal voltage at node b.

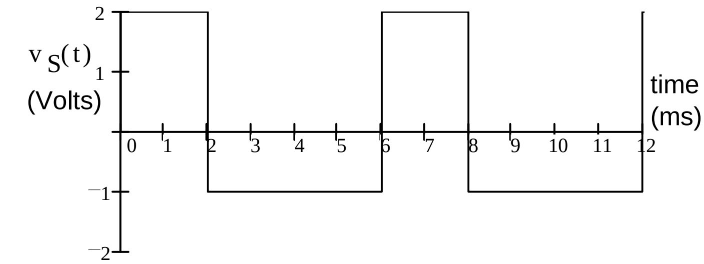
   a) Find $\mathbf{Z_2}$ in polar form



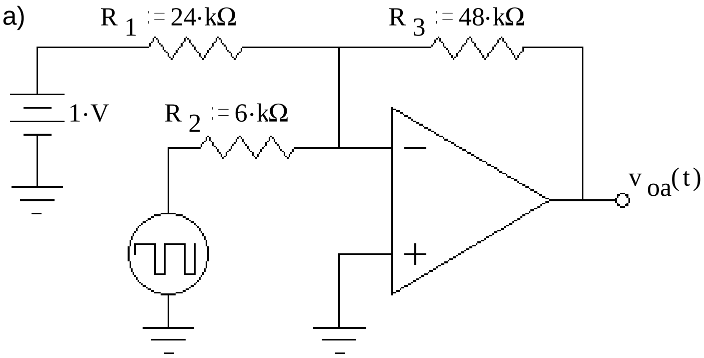
b) $\mathbf{I_1} := (20 - 25 \cdot j) \cdot mA$ Find $\mathbf{V_{in}}$.

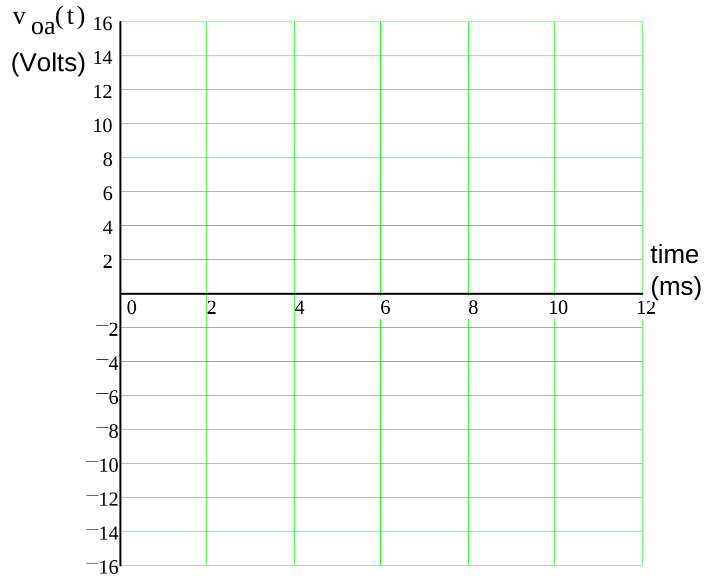
c) Find $\mathbf{Z_1}$ in any form

3. (24 pts) The same input signal (at right) is connected to two 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. The op-amp is connected to +14V & -14V power supplies.

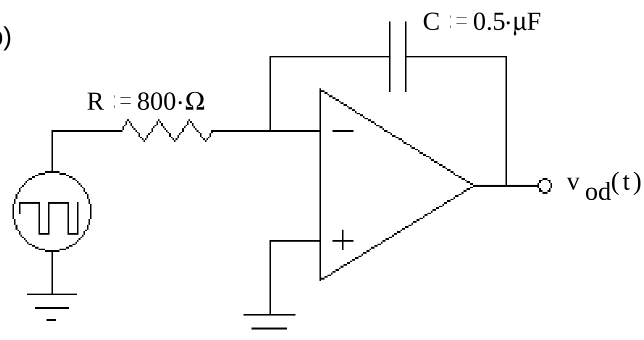


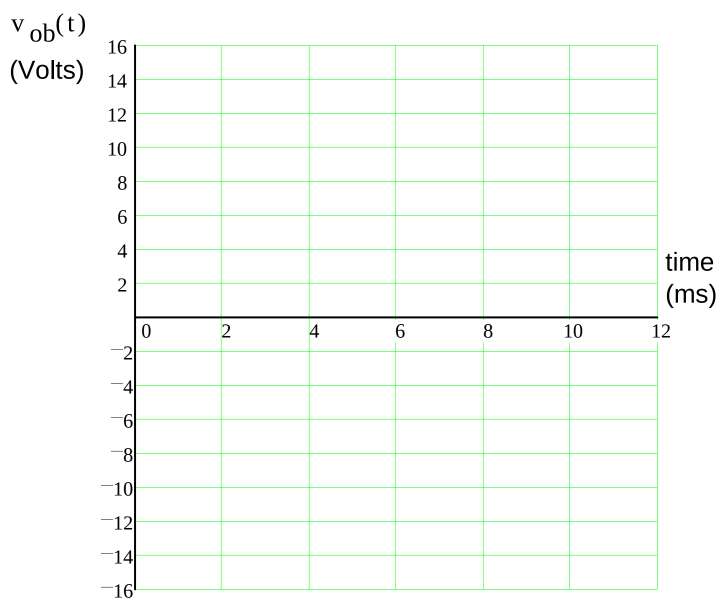
a)





b)



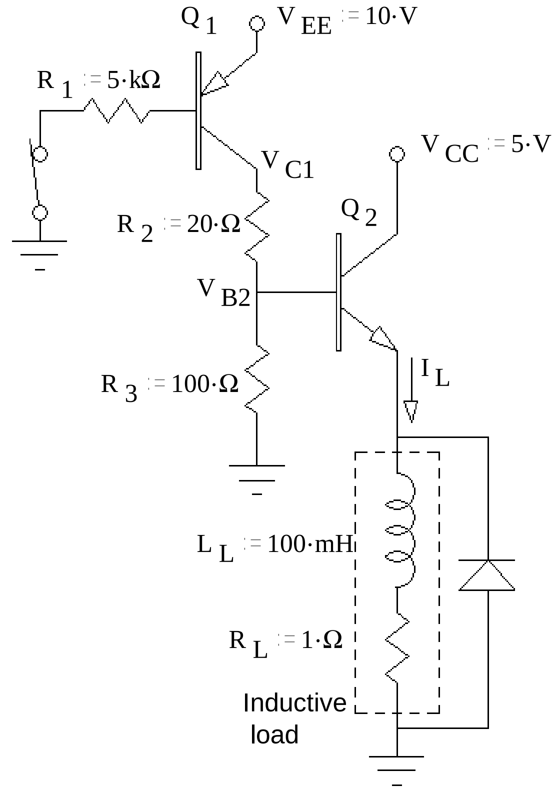


4. (34 pts) A couple of transistors are used to control the current flow through an inductive load. The switch has been closed, as shown, for a long time.

   a) Assume both transistors are in saturation. Find the minimum β for transistor Q_2. β_2 = ?

      Hint: You will need to find the voltage at the base of Q_2.

      You may assume that $I_E \simeq I_C$ for both transistors.



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

c) Something is wrong. Transistor Q_2 is getting too hot. You measure the voltage across the load and find that $V_L := 3 \cdot V$. How much power is being dissipated in transistor Q_2 ?

d) Next you measure the voltage at the collector of Q_1 and find that $V_{C1} := 8.2 \cdot V$ with respect to ground.

Find the actual βs of both transistors and tell me what's wrong.

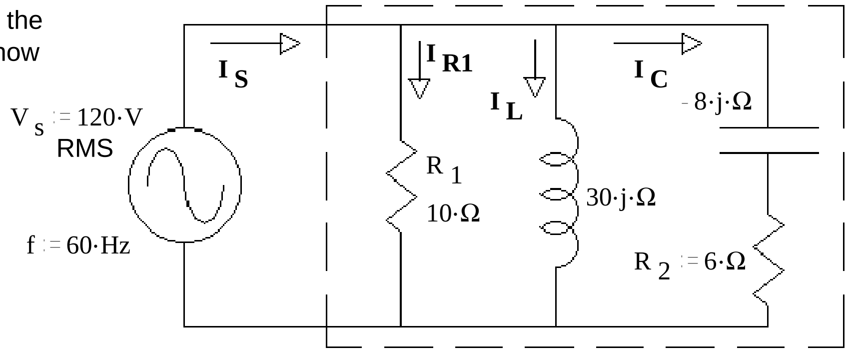
You replace the faulty component and everything is back to the way is was in part a)

e) The diode in this circuit conducts a significant current: (circle one)

A) never.	D) always.
B) when the switch closes.	E) when the switch opens.
C) whenever the switch is closed.	F) whenever the switch is open.

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

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.
$|I_{R1}| = ?$ $|I_L| = ?$ $|I_C| = ?$

b) The real power. P = ?

c) The reactive power. Q = ?

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

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

5. continued f) The power factor. pf = ?

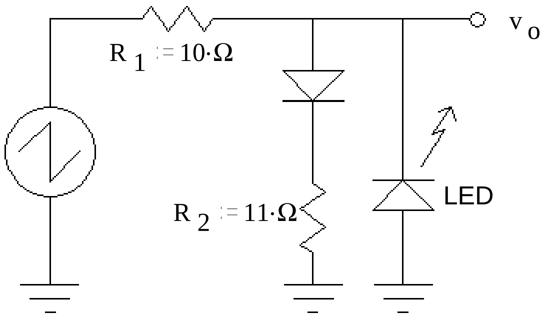
g) The power factor is: i) leading ii) lagging
(circle one)

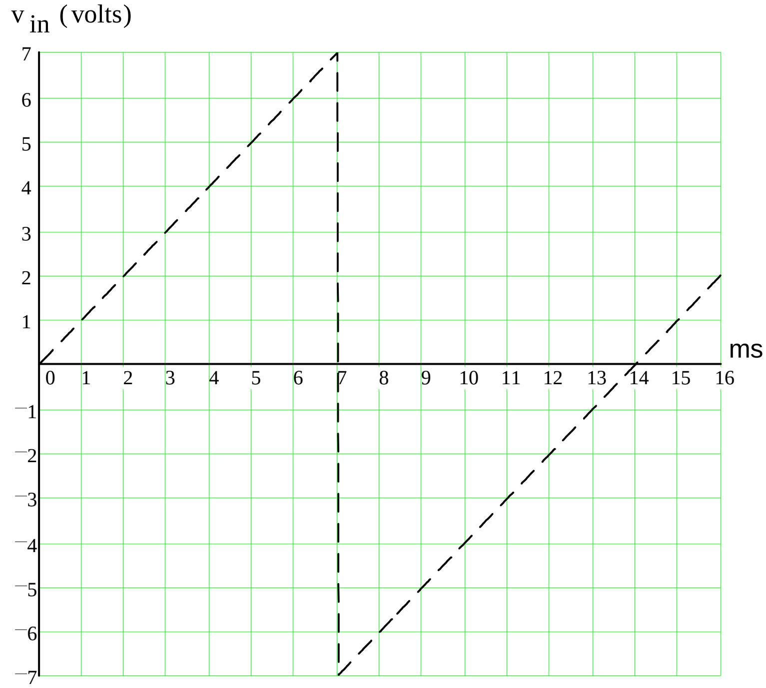
h) The magnitude of the source current. $|\mathbf{I}_S|$ = ?

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.

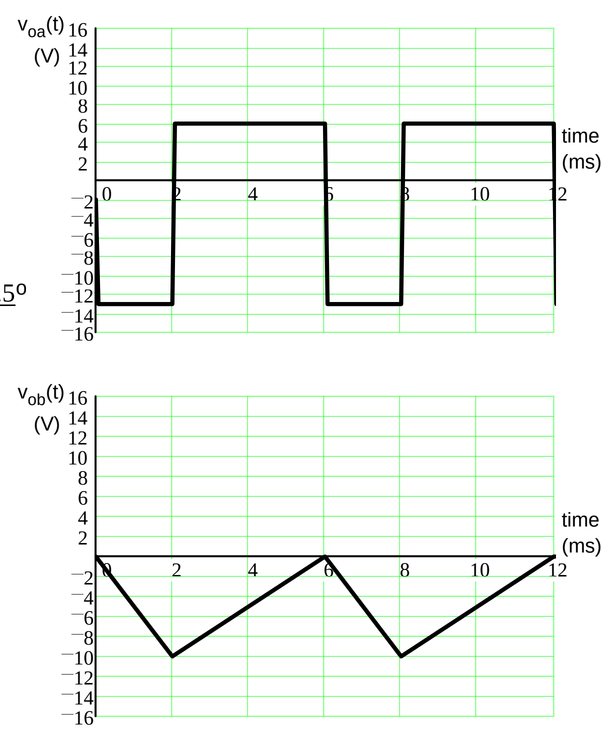
j) Find the new magnitude of the source current. $|\mathbf{I}_S|$ = ?

6. (22 pts) A voltage waveform (dotted line) is applied to the circuit shown. Accurately draw the output waveform (v_o) you expect to see. Label important times **and** voltage levels.





3.



Answers

1. $5.2\cdot V$ $213\cdot mA$ 2. a) 125Ω / -56.2º   b) $7.77V$ / 11.9º   c) 168Ω / 29.5º

4. a) 30 or 29 is more correct
   b) 115.6   c) $6\cdot W$
   d) 15.96 or 14.96 is more correct
   e) E)   g) $4.8\cdot A$

5. a) $12\cdot A$ $4\cdot A$ $12\cdot A$
   b) $2304\cdot W$ c) $672\cdot VAR$
   d) $(2304 - 672\cdot j)\cdot VA$
   e) $2400\cdot VA$ f) 0.96
   g) i)   h) $20\cdot A$
   i) Add a 33.2mH inductor in parallel with load.
   j) $19.2\cdot A$

6.