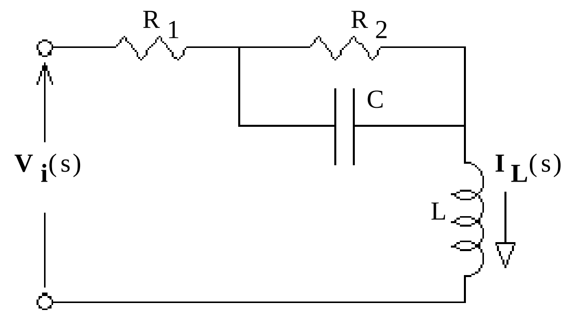
ECE2210 Final given: Fall 16



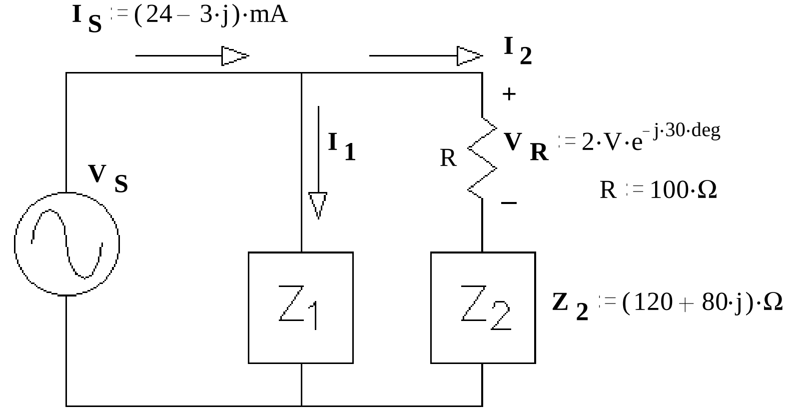
1. (17 pts) a) Find the s-type transfer function of the circuit shown. $\mathbf{V_i}$ is the input and $\mathbf{I_L}$ is the output.
   You <u>MUST</u> show work to get credit.Simplify your expression for $\mathbf{H}(s)$ so that the denominator is a simple polynomial.
   $\mathbf{H}(s)$ = ?

   b) Find the characteristic equation of the circuit shown.

   c) The solutions to the characteristic equation are called the __________ of the transfer function.
   d) Does the transfer function have one or more zeros? If yes, express it (them) in terms of R_1, R_2, C, & L.

2. (20 pts) A Lithium-Ion battery pack is used to power an MP3 Player. When the player is switched on the battery pack voltage drops from 3.70 V to 3.65 V and the player draws 20 mA.
   a) Draw a simple, reasonable model of the battery pack using ideal parts. Find the value of each part.
   b) When MP3 player is used to play loud music it draws 80 mA. What is the battery pack voltage now?
   c) Assuming the battery pack is connected to a load that draws even more current, how much power could this battery pack provide? (Adjust the load to get the maximum output power and tell me how much power that is.)
   d) The battery pack is dissconnected from all loads and is placed in a charger. The charger supplies 4.40 V. How much current flows into the battery pack?

3. (22 pts) For partial credit, you must show work and/or intermediate results.
   a) Find $\mathbf{I_2}$ in any form.

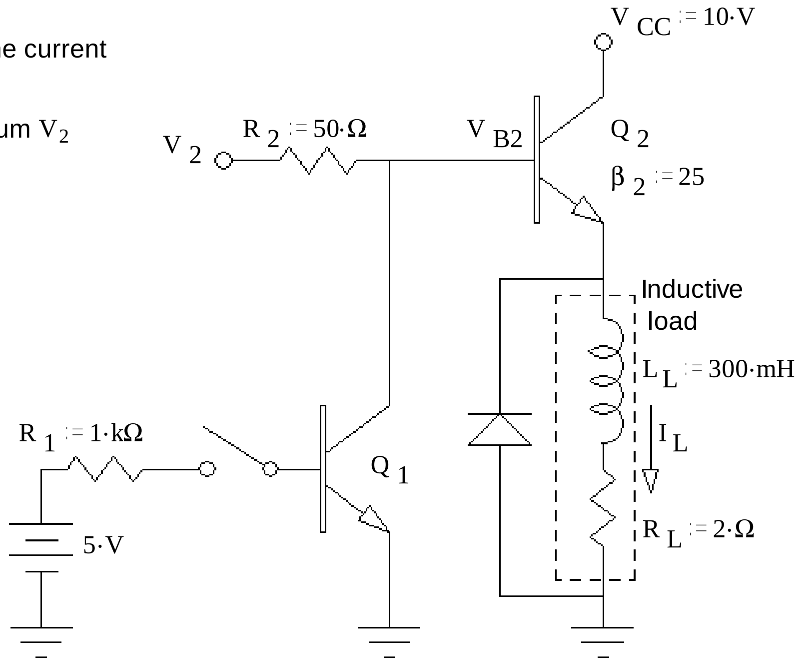


   b) Find $\mathbf{V_S}$ in polar form.

   c) Find $\mathbf{I_1}$ in any form.

   d) Find $\mathbf{Z_1}$ in any form.

4. (35 pts) A couple of transistors are used to control the current flow through an inductive load.



a) The switch is open, as shown. What is the minimum V_2 needed to insure that transistor Q_2 is in saturation.
$\beta_2 = 25$ $V_2 = ?$

b) Find the power dissipated in transistor Q_2 with this V_2. $P_{Q2} = ?$

c) What if the voltage V_2 was too low so that the base voltage of transistor Q_2 was only 8V, how much power would be dissipated in transistor Q_2? IF $V_{B2} := 8 \cdot V$ $P_{Q2} = ?$

d) The transistor Q_2 was selected to be able to handle the power found in part b) (with a 2x factor of safety). What would happen to transistor Q_2 with the conditions of part c)? (Word answer)

V_2 is **NOT** too low for the remainder of the problem, that is, **use the V_2 found in part a)**.

e) When the switch is closed, you would like transistor Q_1 to saturate. What minimum β_1 would be required to achieve saturation?

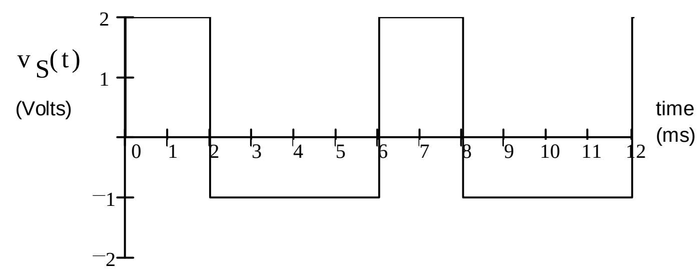
Use the β_1 for the remainder of the problem.

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

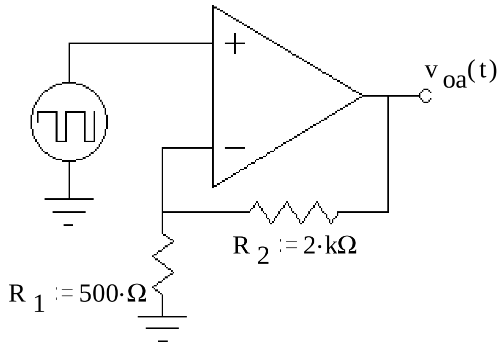
h) This circuit design is: (circle as many as apply and don't forget to say **why**)
A) incredibly fantastic.
B) a very good design.
C) dumb.
D) not a good design.

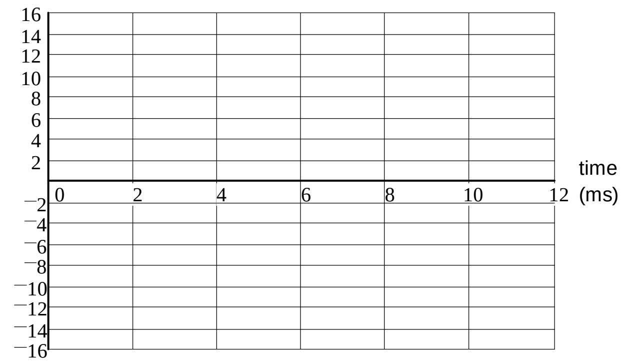
Why?



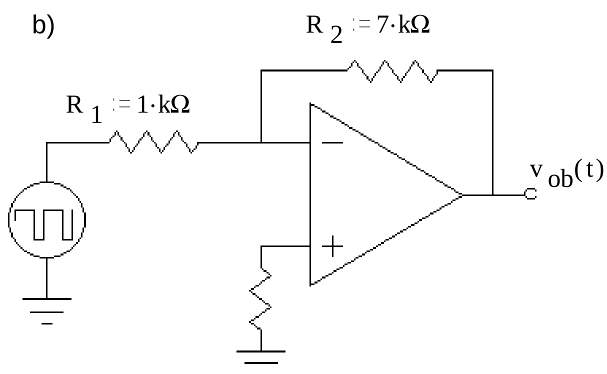
5. (32 pts) The same input signal (at right) is connected to several op-amp circuits below. Sketch the output waveform for each circuit. Clearly label important voltage levels on each output. If I can't easily make out what your peak values are, I'll assume you don't know. Don't forget to show inversions. The op-amp is connected to +12V & -12V power supplies.

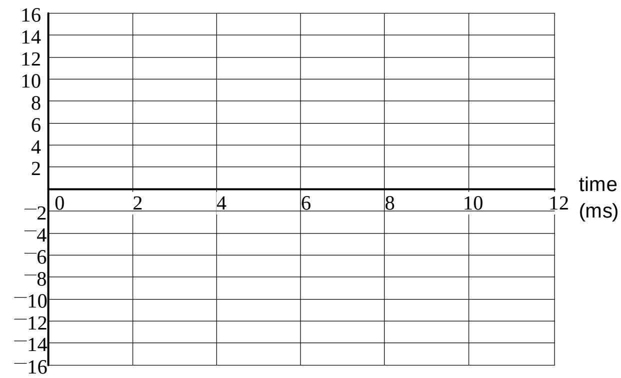
a)





b)





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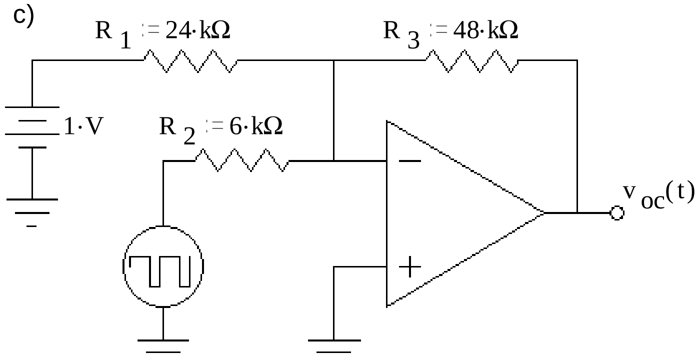
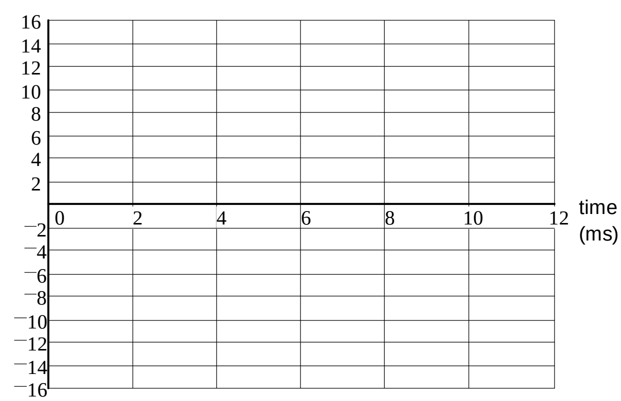
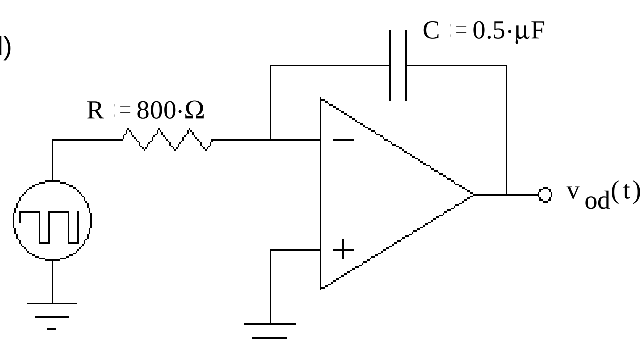
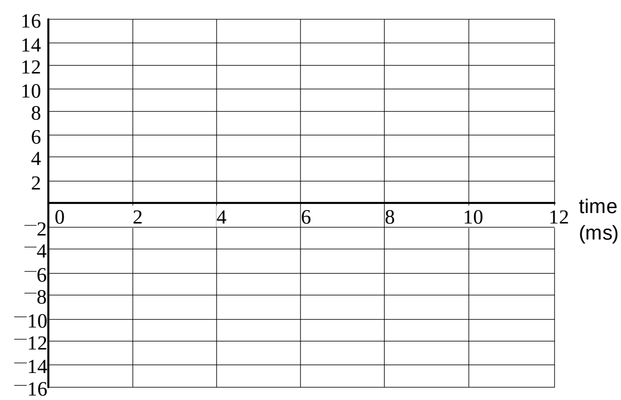




d)



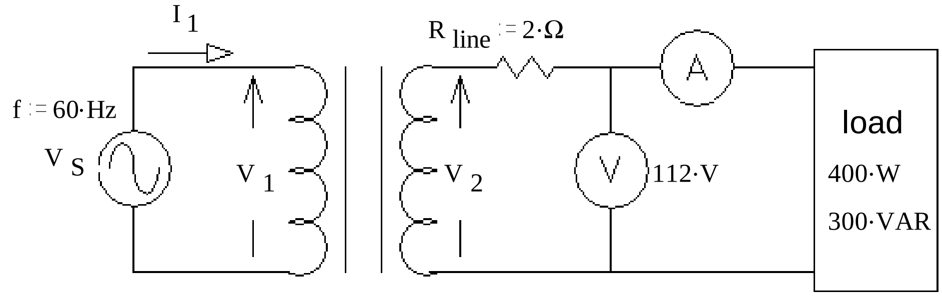


6. (34 pts) A load is connected as shown. The load uses 400W and 300VAR. The RMS voltmeter measures 112 V.

Find the following:
(Be sure to use correct units for each value.)

a) The apparent power used by the load. $|\mathbf{S}| = ?$

b) The load's power factor. $pf = ?$



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

d) What does the RMS ammeter measure?

e) The load consists of two parts in series. Draw the parts in the box above and find the values. $\omega := 377\cdot\frac{rad}{sec}$

f) How much power does R_{line} waste? $P_{Rline} = ?$

g) How much power does the source provide? $P_S = ?$

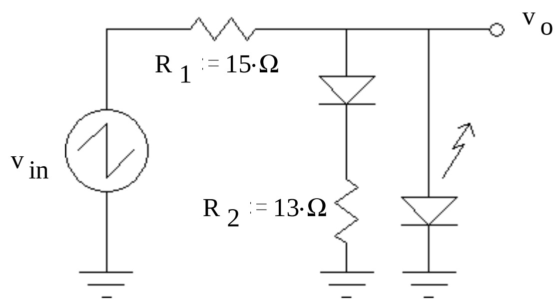
h) What is the secondary voltage? $|V_2| = ?$ Hint: Remember, you can't add magnitudes of complex numbers.

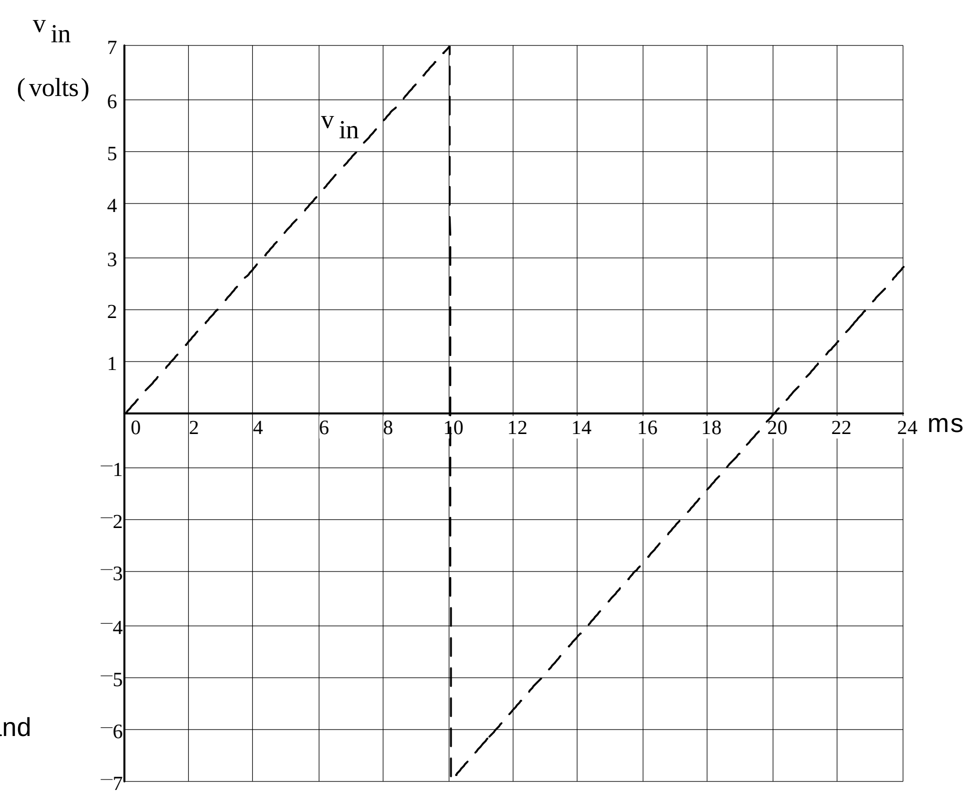
i) The transformer shown in the circuit is ideal. It is rated at 900/300 V, 1 kVA, 60 Hz. Find V_1. $|V_1| = ?$

j) Is this transformer operating within its ratings? Show your evidence.

k) The load box cannot be opened. Add (draw it) another component to the circuit above which can correct the power factor (make $pf = 1$). Show the correct component in the correct place and <u>find its value</u>. This component should not affect the real power consumption of the load.

8. (20 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.





If you're not specific about your times and voltages, I'll assume you don't know !

7. Do you want your grade and scores posted on the Internet?
   If your answer is yes, then provide some sort of alias: ________________________
   otherwise, leave blank

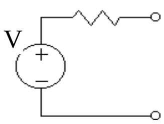
   The grades will be posted on line in pdf form in alphabetical order under the alias that you provide here. I **will not** post grades under your real name or an alias that looks like a real name or u-number. The pdf spreadsheet will show the homework, lab, and exam scores of everyone who answers here.

<u>Answers</u>

1. a) $$\frac{\frac{1}{L}\cdot s+\frac{1}{L\cdot C\cdot R_2}}{s^2+\left(\frac{R_1}{L}+\frac{1}{R_2\cdot C}\right)\cdot s+\left(1+\frac{R_1}{R_2}\right)\cdot\frac{1}{L\cdot C}}$$

   b) $0 = s^2+\left(\frac{R_1}{L}+\frac{1}{R_2\cdot C}\right)\cdot s+\left(1+\frac{R_1}{R_2}\right)\cdot\frac{1}{L\cdot C}$ c) poles d) $-\frac{1}{L\cdot C\cdot R_2}$

2. a) $3.7\cdot V$ $2.5\cdot\Omega$



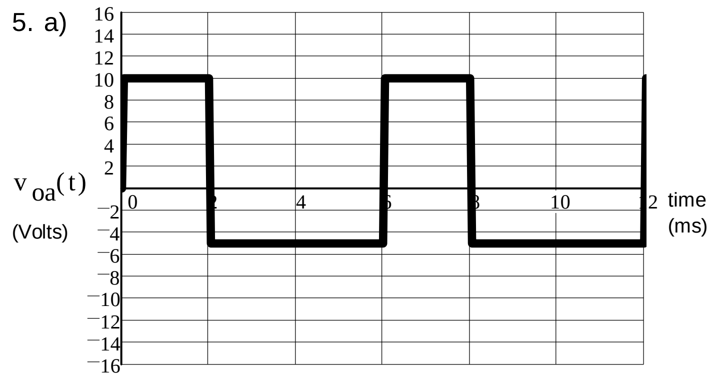
   b) $3.5\cdot V$
   c) $1.37\cdot mW$
   d) $280\cdot mA$

3. a) $20\cdot mA\cdot e^{-j\cdot 30\cdot deg}$ b) $4.68\cdot V\cdot e^{-j\cdot 10\cdot deg}$
   c) $9.68\cdot mA\cdot e^{j\cdot 46.3\cdot deg}$ d) $484\cdot V\cdot e^{-j\cdot 56.4\cdot deg}$

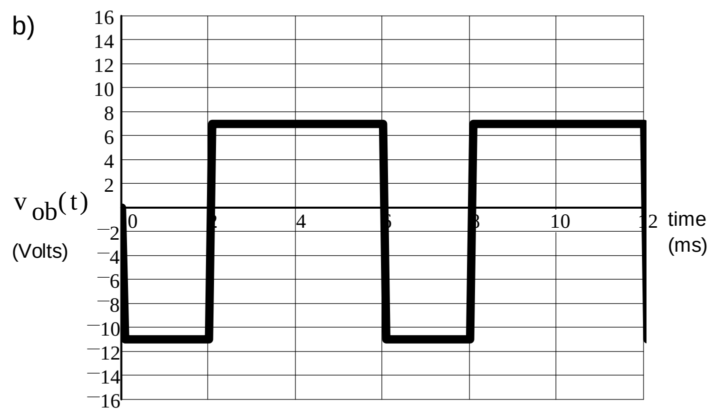
4. a) $20.3\cdot V$ b) $0.98\cdot W$ c) $9.86\cdot W$
   d) Q_2 will burn out. e) 93.5 f) B g) $4.9\cdot A$
   h) C D There are good ways to do this same thing without the extra requirement of V_2, and this extra voltage makes the transistor Q_2 more vulnerable to failure (see part d)).

5. at right

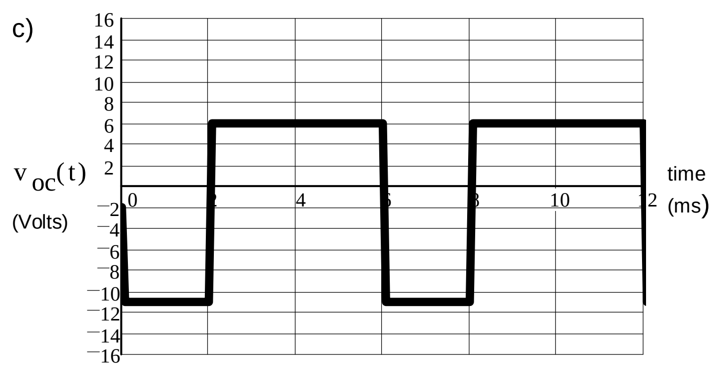
5. a)



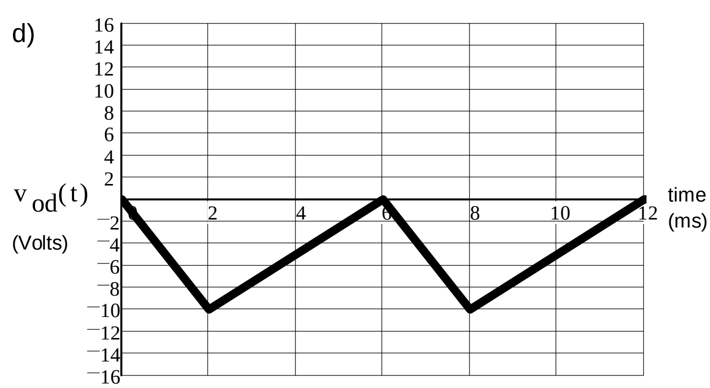
b)



c)



d)



6. a) $500\cdot VA$ b) 0.8 c) ii) d) $4.46\cdot A$
   e) $20.1\cdot\Omega$ $39.9\cdot mH$ f) $39.9\cdot W$ g) $440\cdot W$
   h) $119\cdot V$ i) $358\cdot V$ k) $63.4\cdot\mu F$

8.