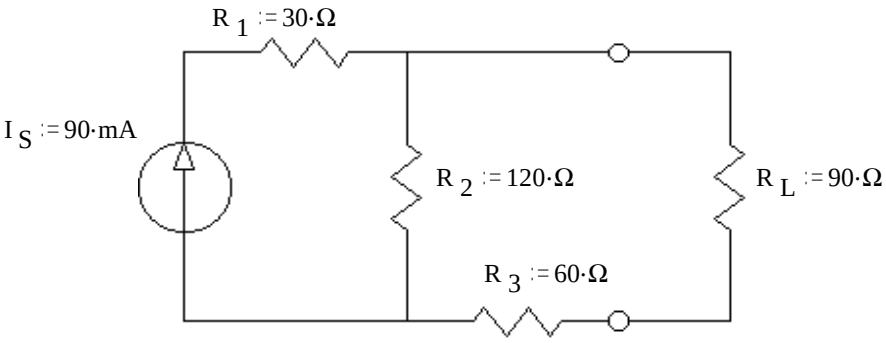
ECE2210 Final given: Fall 12

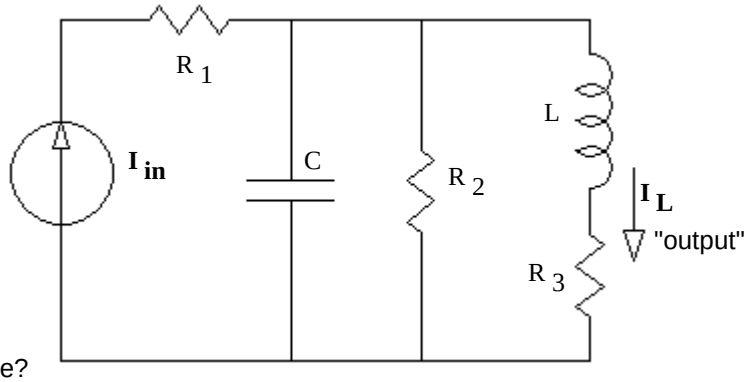
1. (15 pts) a) Find and draw the Thévenin equivalent of the circuit shown. The load resistor is R_L.



   b) Find and draw the Norton equivalent of the same circuit.

   c) Find the load current using your Thévenin equivalent circuit.

2. (15 pts) a) Find the s-type transfer function of the circuit shown. Consider $\mathbf{I_{in}}$ as the input and $\mathbf{I_L}$ as the "output".



   You MUST show work to get credit. Simplify your expression for H(s) so that the denominator is a simple polynomial with no coefficient before the highest-order s term in the denominator.

   $\mathbf{H}(s)$ = ?

   b) How many zeroes does this transfer function have?

   If it has 1 or more, express them (probably in terms of R_1, R_2, R_3, L and C).

   c) How many poles does this transfer function have?

3. (22 pts) A generator produces 300-V , 60-Hz power. It is connected through an extension cord to a single load which consumes 1.2 kW with a 80% lagging power factor. The total resistance of the wires in the extension cord is R_{line}. The system efficiency is 96%.

   Source end: 300-V wires: R_{line} Efficiency: 96% = $\frac{P_{out}}{P_{in}}$ Load end: 1.2 kW, 80% pf, lagging

   a) Find the complex power (P and Q) provided by the source.

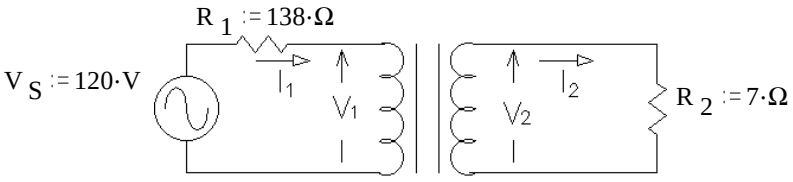
   b) Find the current flowing in each wire of the extension cord.

   c) What is the value of the line resistance? R_{line} = ?

   d) What is the line voltage at the load? Just magnitude.

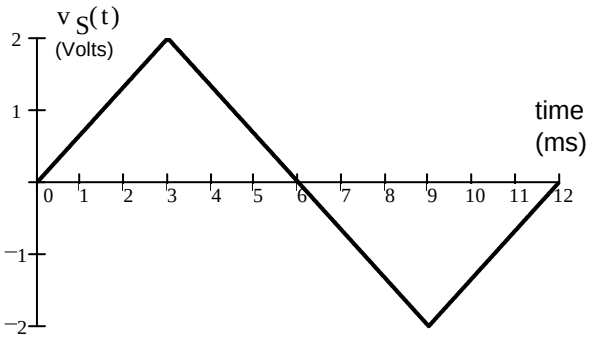
4. (12 pts) The transformer shown in the circuit below is ideal. It is rated at 220/55 V, 100 VA, 60 Hz
   Find the following:

   a) V_2 = ?

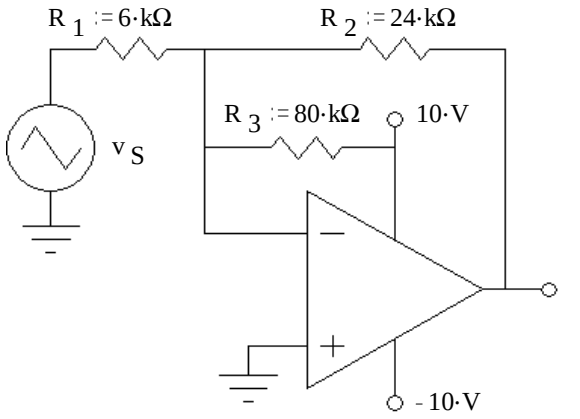


   b) Is this transformer operating within its ratings? Show your evidence.

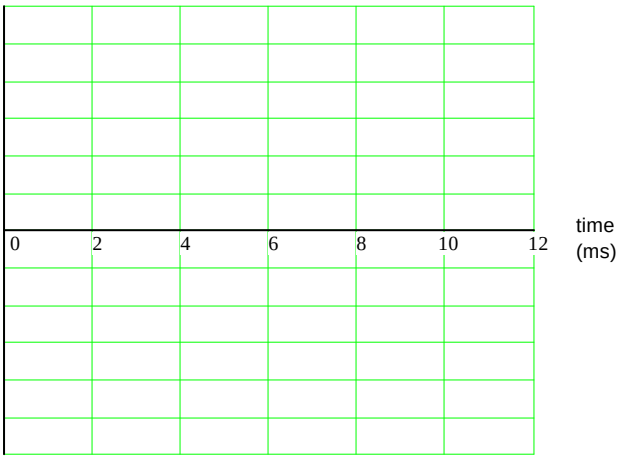
5. (18 pts) The same input signal (at right) is connected to several op-amp circuits.



a) Sketch the output waveform for this circuit. Clearly label important voltage levels on the 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.



$v_{oa}(t)$



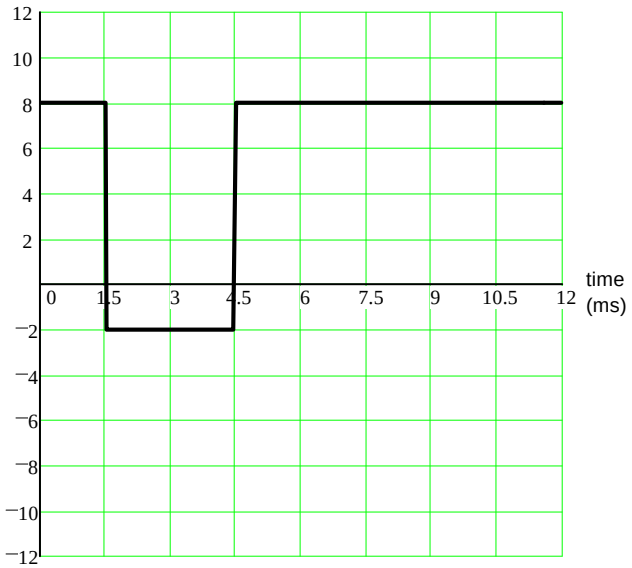
b) Devise an op-amp circuit which will output the waveform shown below given the input waveform shown at right. Choose the power supplies and use whatever passive parts you need.

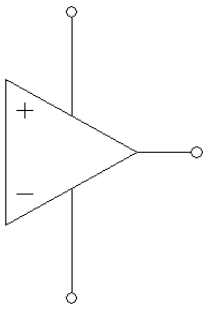
You **may not** use any other batteries, input signals, or power supplies beyond the two that power the op amp.

output

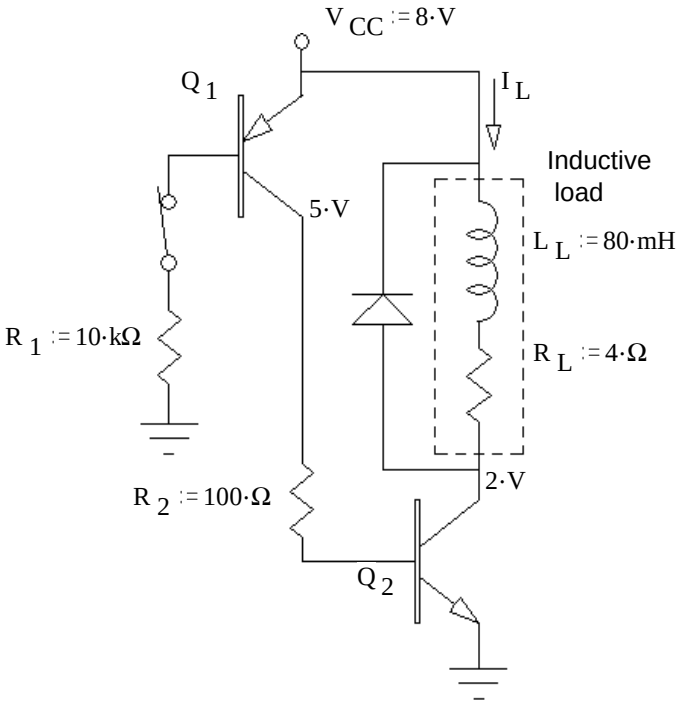
$v_{ob}(t)$

(Volts)





6. (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) You measure the voltage at each collector (referenced to ground) as shown on the drawing. Find the power dissipated by transistor Q_2 .

b) Find the β of transistor Q_2 .

c) Find the β of transistor Q_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 now: $\beta_1 := 200$ Use this from now on.

e) Find the new load current (I_L) assuming transistor Q_2 is in the active region.

f) Check the assumption that Q_2 is in the active region and recaculate I_L if necessary.

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

A) never. C) whenever the switch is closed. E) when the switch opens.

B) when the switch closes. D) always. 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.)

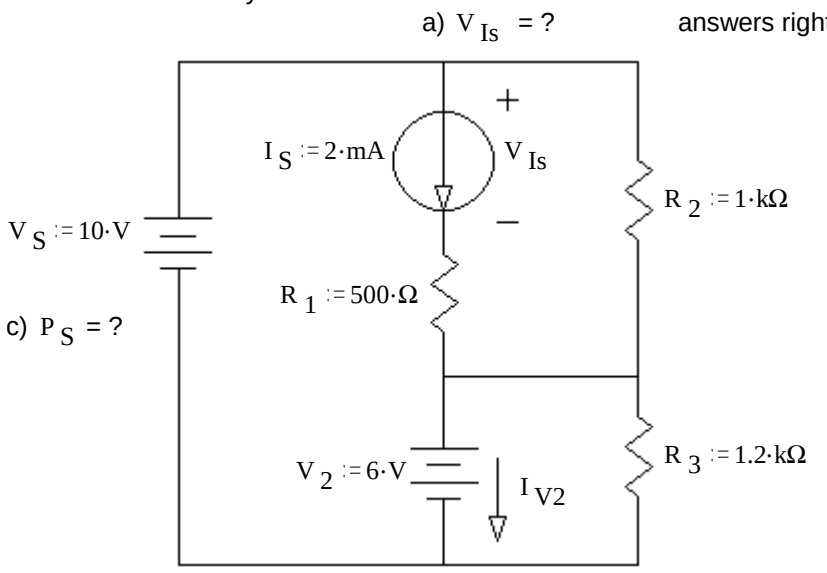
7. (16 pts) Find the values below. Show your work.

a) V_{Is} = ?

b) I_{V2} = ?

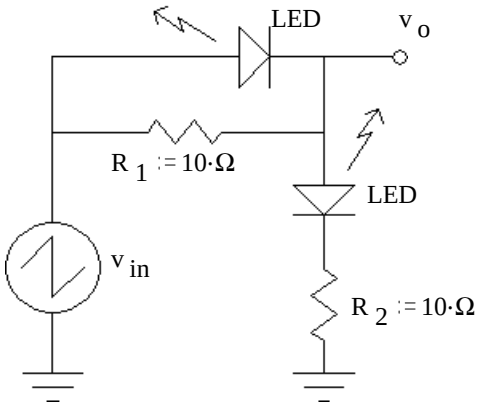
c) P_S = ?

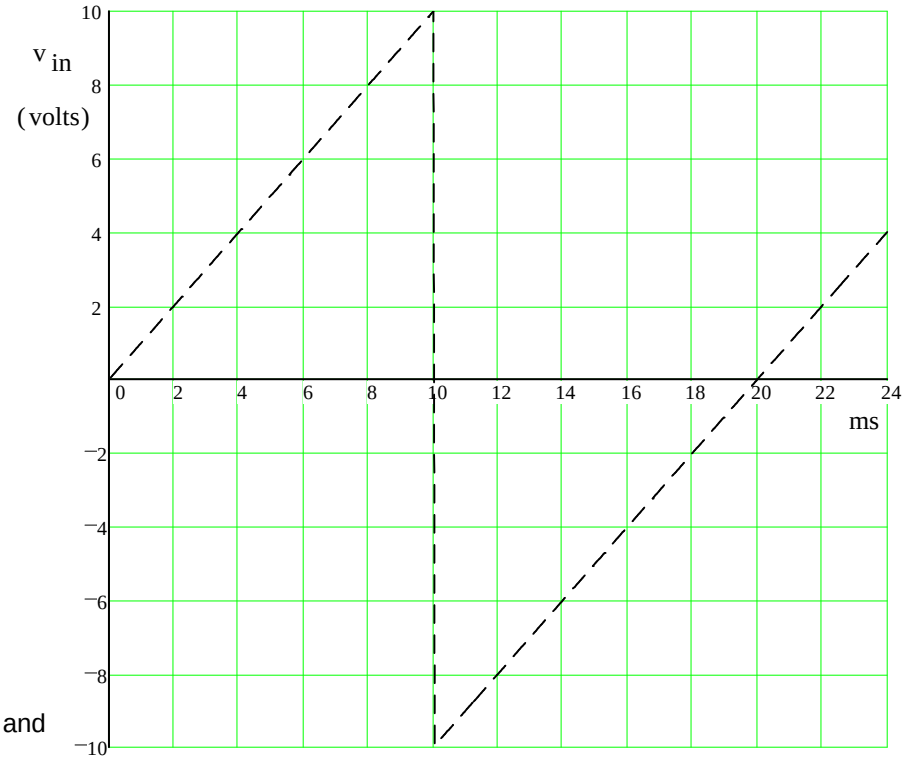
Note: feel free to show work & answers right on the schematic



Use constant-voltage-drop models for the diodes and LEDs on this exam.

8. (18 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.





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

9. (30 pts) Assume that diodes D_1, D_3 and D_4 **DO conduct.**

   Assume that diode D_2 does **NOT** conduct.

   a) Stick with these assumptions even if your answers come out absurd. Find the following and anything else you need in order to check the assumptions:

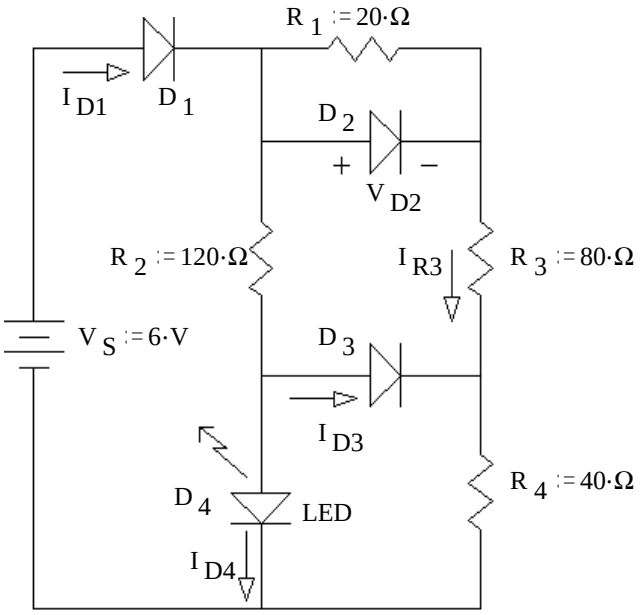
   I_{R3} = _____

   I_{D3} = _____

   V_{D2} = _____

   I_{D4} = _____

   I_{D1} = _____



More on next page ===>

b) Based on the numbers above, was the assumption about D_1 correct? yes no (circle one)
How do you know? (Specifically show a value which is or is not within a correct range.)

c) Was the assumption about D_2 correct? yes no
How do you know? (Show a value & range.)

(circle one)

d) Was the assumption about D_3 correct? yes no
How do you know? (Show a value & range.)

e) Was the assumption about D_4 correct? yes no
How do you know? (Show a value & range.)

f) Based on your answers to parts b), c), d) & e), Circle one:

(circle one)

Justify your answer.

i) The ***real*** $I_{D4} < I_{D4}$ calculated in part a.

ii) The ***real*** $I_{D4} = I_{D4}$ calculated in part a.

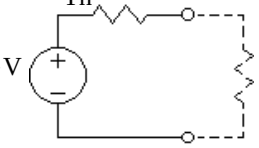
iii) The ***real*** $I_{D4} > I_{D4}$ calculated in part a.

10. Do you want your grade and scores posted on the Internet? _____otherwise, leave blank_____
If your answer is yes, then provide some sort of alias:

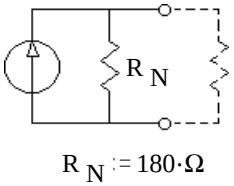
The grades will be posted on line in pdf form in alphabetical order under the alias that you provide here. I will not post grades under your real name. It will show the homework, lab, and exam scores of everyone who answers here.

Answers

1. a) $R_{Th} := 180\cdot\Omega$, $V_{Th} := 10.8\cdot V$



b) $I_N := 60\cdot mA$, $R_N := 180\cdot\Omega$



c) $40\cdot mA$

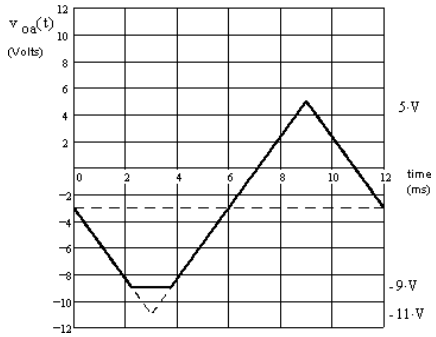
2. a) $$\frac{\frac{1}{L\cdot C}}{s^2+\left(\frac{1}{R_2\cdot C}+\frac{R_3}{L}\right)\cdot s+\frac{1}{L\cdot C}\cdot\left(\frac{R_3}{R_2}+1\right)}$$

b) 0 c) 2

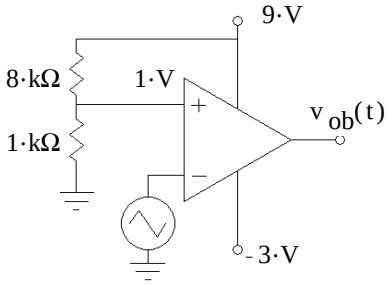
3. a) $1.25+0.9\cdot j\ kVA$ b) $5.134\cdot A$ c) $1.90\cdot\Omega$ d) $292\cdot V$

4. a) $13.4\cdot V$ b) $1.92\cdot A$

5. a)



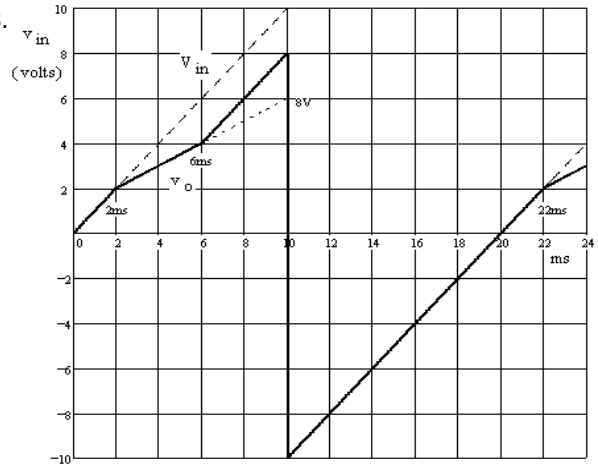
b) one possible solution



6. a) $3\cdot W$ b) 34.9 c) 58.9
d) 97.3 e) $2.48\cdot A$ f) $1.95\cdot A$
g) E h) $1.95\cdot A$

7. a) $3\cdot V$ b) $1\cdot mA$ c) $60\cdot mW$

8.



9. a) $40\cdot mA$ $-7.5\cdot mA$ $0.8\cdot V$ $35\cdot mA$ $67.5\cdot mA$

b) yes $I_{D1} = 67.5\cdot mA > 0$

c) no $V_{D2} = 0.8\cdot V > 0.7V$

d) no $I_{D3} = -7.5\cdot mA < 0$

e) yes $I_{D4} = 35\cdot mA > 0$

f) i The additional current from D_3 doesn't really flow.