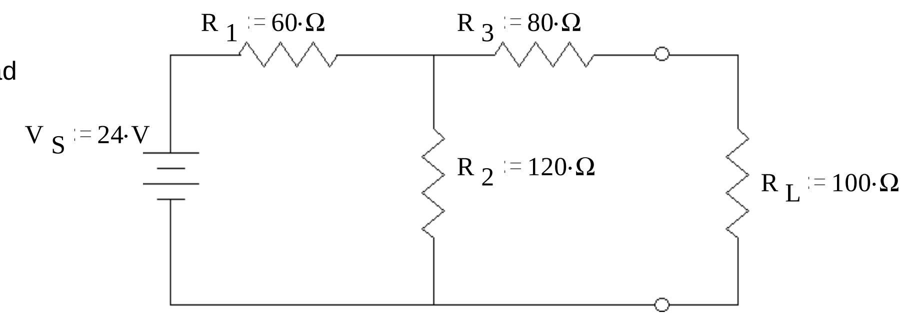
ECE2210 Final given: Fall 09

1. (19 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. (12 pts) a) Find the s-type transfer function of the circuit shown. Consider I_C as the "output".

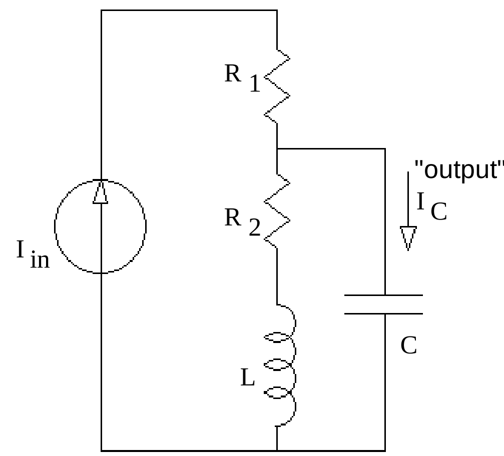
   You MUST show work to get credit. Simplify your expression for $H(s)$ so that the denominator is a simple polynomial.

   $$\mathbf{H}(s) = \frac{\mathbf{I_C}(s)}{\mathbf{I_{in}}(s)} = ?$$

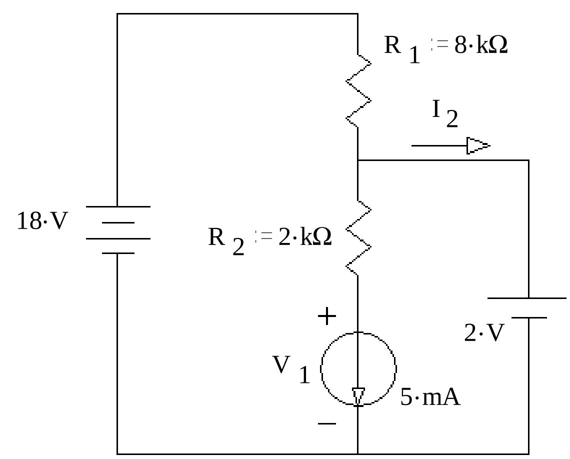
   b) How many poles does this transfer function have?

   c) How many zeroes does this transfer function have?

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



3. (15 pts) a) Find: V_1 & I_2

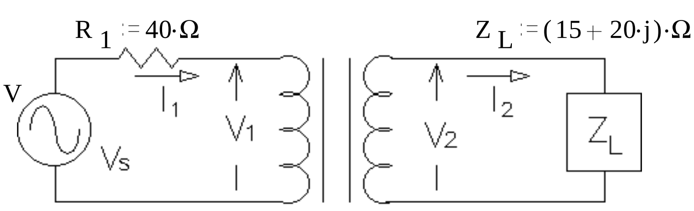


   b) How much power does the 2-V battery supply to the circuit?

4. (21 pts) The transformer shown in the circuit below is ideal. It is rated at 220/110 V, 200 VA, 60 Hz

   Find the following:

   All values are RMS unless specified otherwise.



   a) The primary current (magnitude). $|\mathbf{I_1}| = ?$

   b) The primary voltage (magnitude). $|\mathbf{V_1}| = ?$

   c) The secondary voltage (magnitude). $|\mathbf{V_2}| = ?$

   d) The power supplied by the source. $P_S = ?$

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

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

5. (22 pts) Assume that diode D_1 does **NOT** conduct.

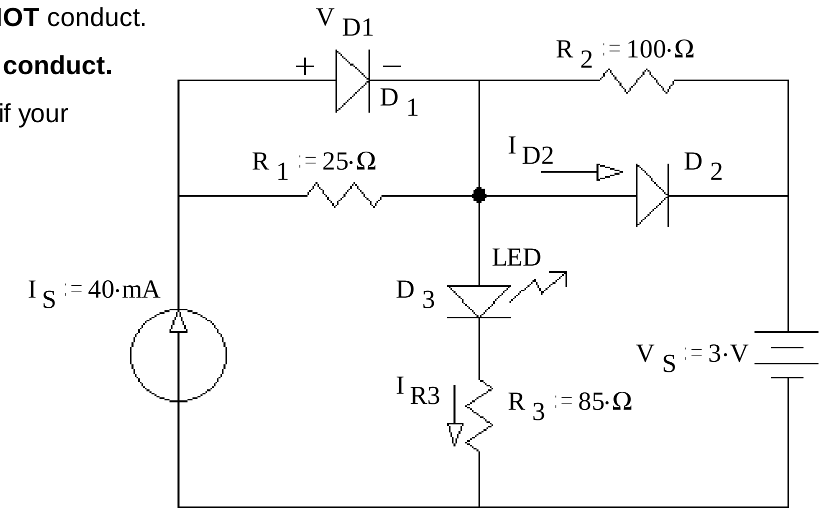
   Assume that diodes D_2 and D_3 **DO conduct.**

   a) Stick with these assumptions even if your answers come out absurd.
   Find the following:

   V_{D1} = ____________

   I_{R3} = ____________

   I_{D2} = ____________



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

   c) Based on the numbers above, was the assumption about D_2 correct? Circle one: yes no
   How do you know? (Specifically show a value which is or is not within a correct range.)

   d) Based on the numbers above, was the assumption about D_3 correct? Circle one: yes no
   How do you know? (Specifically show a value which is or is not within a correct range.)

5. continued

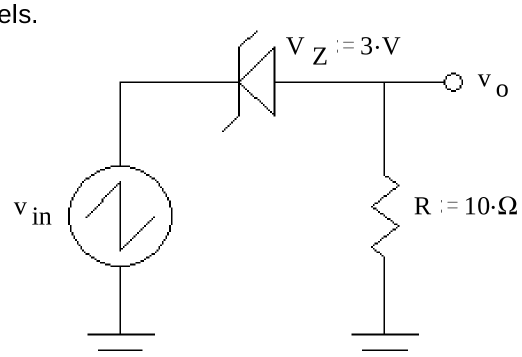
   e) Based on your answers to parts b), c) & d), Circle one:

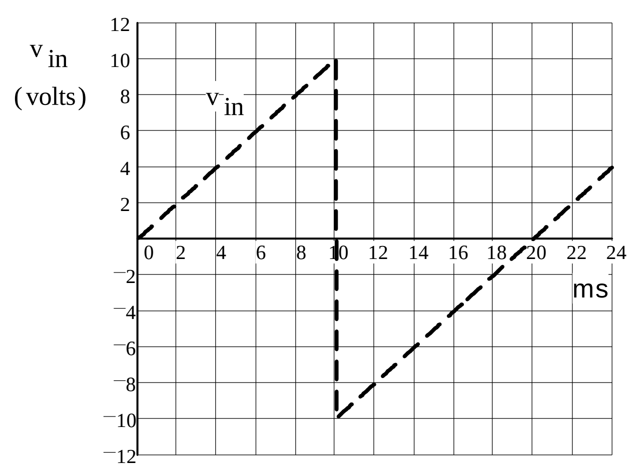
   i) The ***real*** $I_{R3} < I_{R3}$ calculated in part a.

   ii) The ***real*** $I_{R3} > I_{R3}$ calculated in part a.

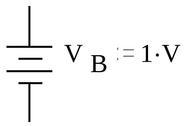
   iii) The ***real*** $I_{R3} = I_{R3}$ calculated in part a.

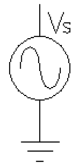
6. (16 pts) A voltage waveform (dotted line) is applied to the circuit shown. <u>Accurately</u> draw the output waveform (v_o) you expect to see. Label important times **<u>and</u>** voltage levels.

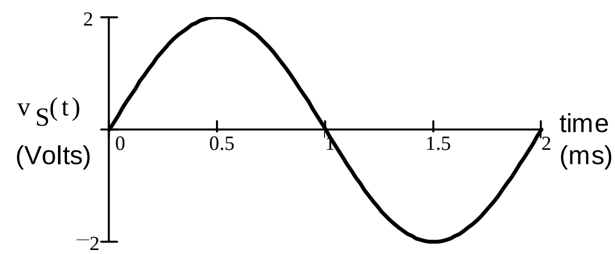




7. (34 pts) You have two input voltages to work with.
A 1V battery and the waveform (at right).

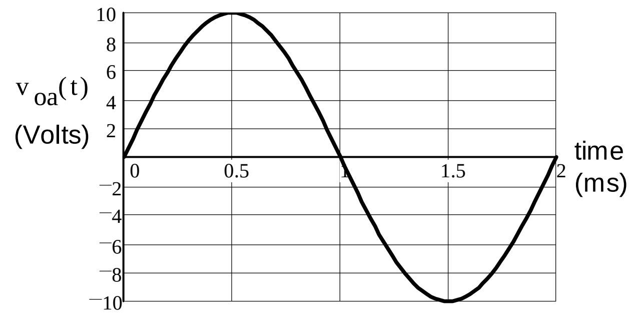




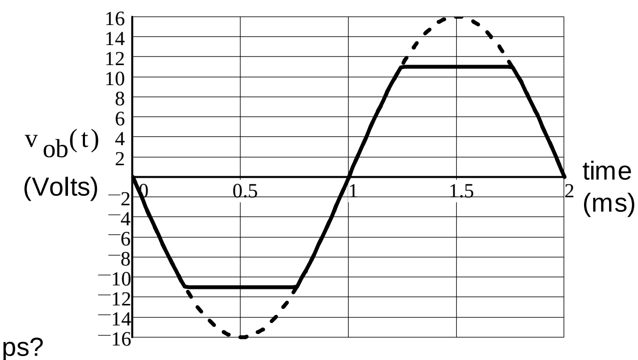


The problems below are op-amp design problems. The answer should be a schematic of a circuit showing the values of all the parts. Use reasonable resistor values (in the 100Ω to 1 MΩ range). Also show how one or both of the sources are hooked up to your circuit. Most circuits won't need both.

a) Design a circuit which will output the waveform at right.

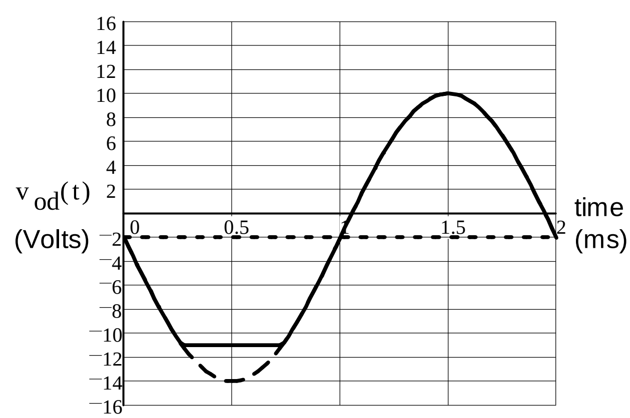


b) Design a circuit which will output the waveform at right.

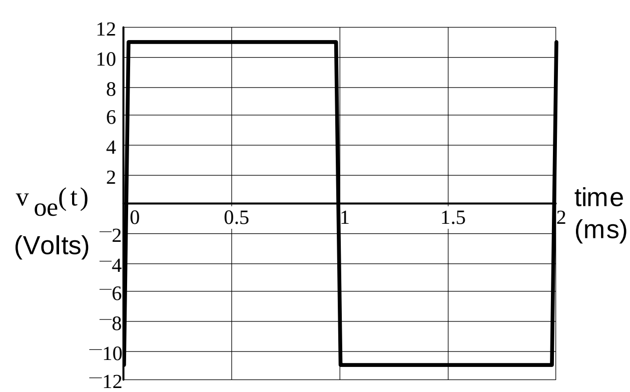


c) What power supply or supplies are being used with your op-amps?

d) Design a circuit which will output the waveform at right.



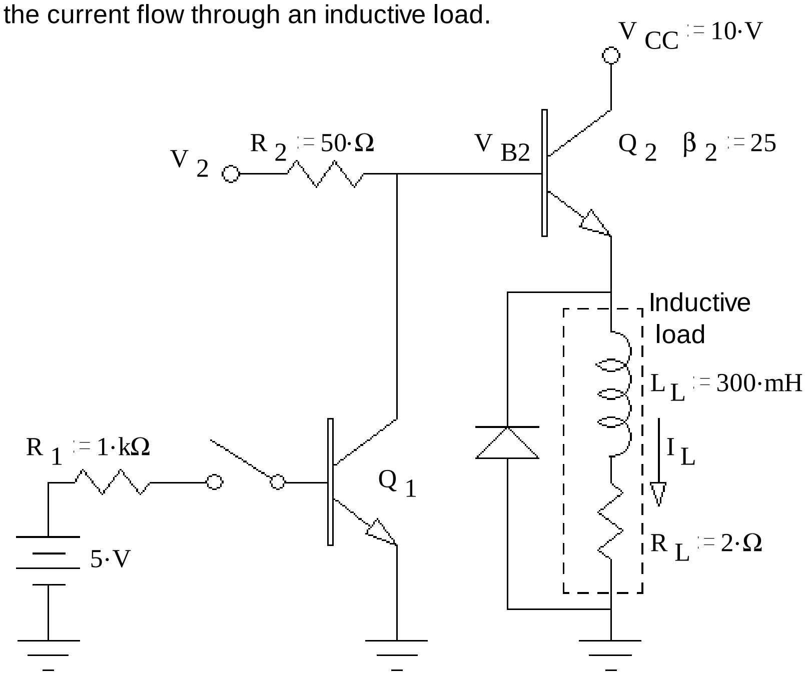
e) Design a circuit which will output the waveform at right.
Hint: Think nonlinear.



8. (31 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.

$\beta_2 = 25$ $\quad V_2 = ?$



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

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 $V_{B2} := 8 \cdot V$ $\quad P_{Q2} = ?$

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 with the V_2 of part c)?

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.

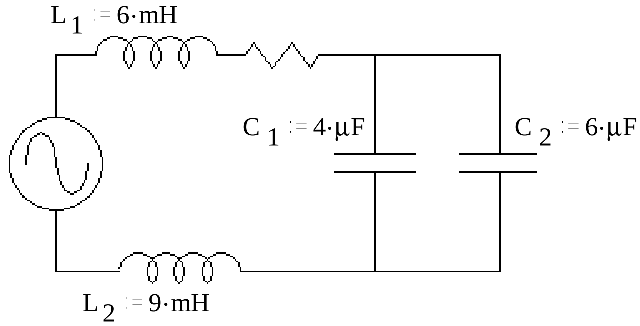
f) The diode in this circuit conducts a significant current: (circle one)
- A) never.
- B) when the switch closes.
- C) whenever the switch is closed.
- D) always.
- E) when the switch opens.
- F) whenever the switch is open.

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:
- A) incredibly fantastic.
- B) a very good design.
- C) dumb.
- D) not a good design.

Why?

9. (10 pts) Find the resonant frequency (or frequencies) of the circuit shown (in cycles/sec or Hz).

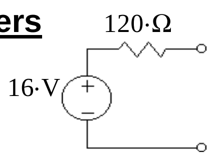


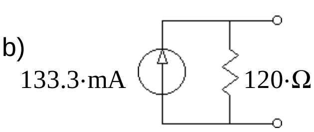
10. Do you want your grade and scores posted on my door and on the Internet? If your answer is yes, then provide some sort of password

or alias: ______________________________
otherwise, leave blank

The grades will be posted on my door in alphabetical order under the alias that you provide here. I will not post grades under your real name. The Internet version will be a pdf file which you can download. Both will show the homework, lab, and exam scores of everyone who answers here.

Answers

1. a) 

b) 

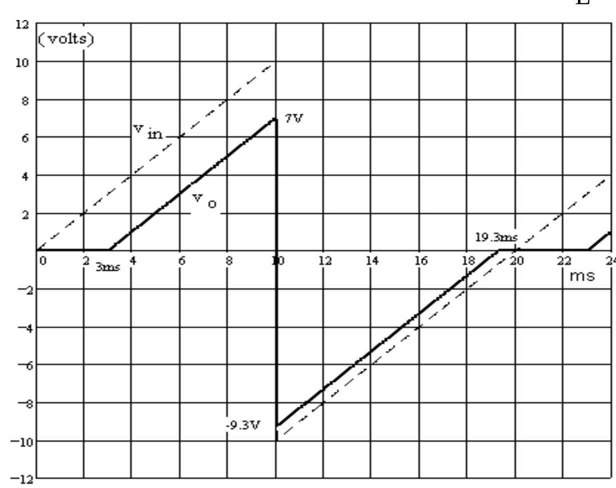
c) $72.7 \cdot mA$

2. a) $\dfrac{s^2 + \dfrac{R_2}{L} \cdot s}{s^2 + \dfrac{R_2}{L} \cdot s + \dfrac{1}{L \cdot C}}$ b) 2 c) 2 , 0 & $-\dfrac{R_2}{L}$

3. a) $-8 \cdot V$ $-3 \cdot mA$ b) $6 \cdot mW$

4. a) $937 \cdot mA$ b) $93.7 \cdot V$ c) $46.85 \cdot V$
d) $87.8 \cdot W$ e) NO $I_{1max} := 909 \cdot mA < I_1$

5. a) $1 \cdot V$ $20 \cdot mA$ $13 \cdot mA$ b) no $V_{D1} = 1 \cdot V > 0.7V$
c) yes $I_{D2} = 13 \cdot mA > 0$ d) yes $I_{D3} = 20 \cdot mA > 0$ e) iii)

6. 

7. a) Non-inverting amp with $R_f = 4R_1$.
b) Inverting amp with $R_f = 8R_1$. c) $\pm$ 12V
d) Summer with $R_f = 6R_1$, waveform is hooked to R_1 & $R_f = 2R_2$, battery + terminal is hooked to R_2 and **-** to ground.
e) Comparator, waveform is hooked to noninverting input, other inputis hooked to ground.

8. 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)).

9. $411 \cdot Hz$