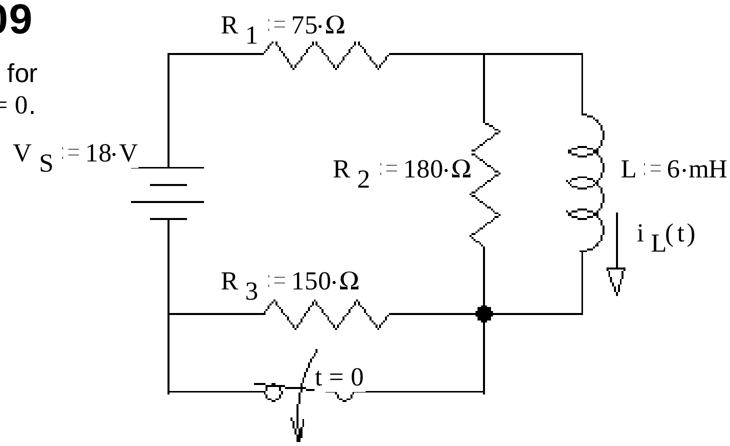
ECE2210 Final given: Spring 09

1. (22 pts) The switch has been open (not making contact) for a long time and is switched closed (as shown) at time $t = 0$.

   a) Find the complete expression for $i_L(t)$.

   b) Find i_L at time $t = 1.2\tau$.

   c) At time $t = 1.2\tau$ the switch is opened again. Will the time constant be different now? If yes, find the new time constant.



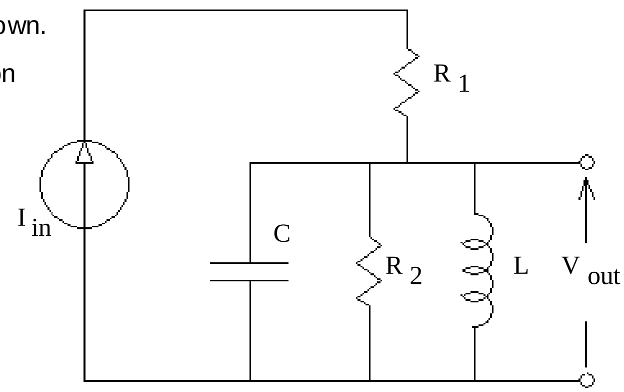
2. (12 pts) a) Find the s-type transfer function of the circuit shown.

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

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

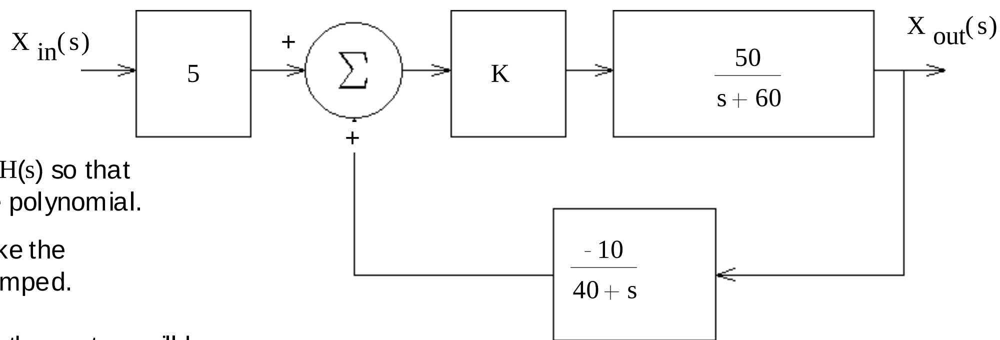
   b) How many poles does this transfer function have?

   c) Does the transfer function have any zeroes? If yes, express them in terms of the circuit parts.



3. (17 pts) a) A feedback system is shown in the figure. What is the transfer function of the whole system, with feedback.

   $$H(s) = \frac{X_{out}(s)}{X_{in}(s)} = ?$$

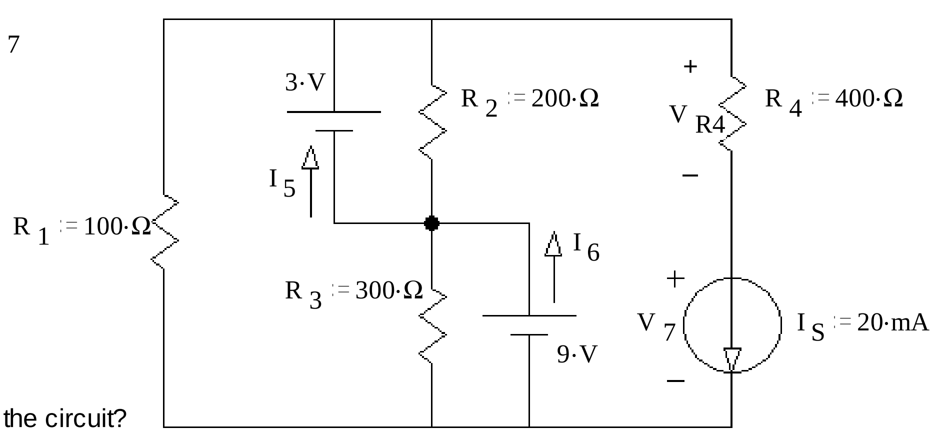


   Simplify your expression for $H(s)$ so that the denominator is a simple polynomial.

   b) Find the value of K to make the transfer function critically damped.

   c) If K is **less** than this value the system will be:
   underdamped or overdamped Circle one

4. (18 pts) a) Find: I_5 I_6 & V_7



   b) I_S Supplies how much power to the circuit?

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

5. (22 pts) Assume that diodes D_1 and D_3 **DO conduct.**

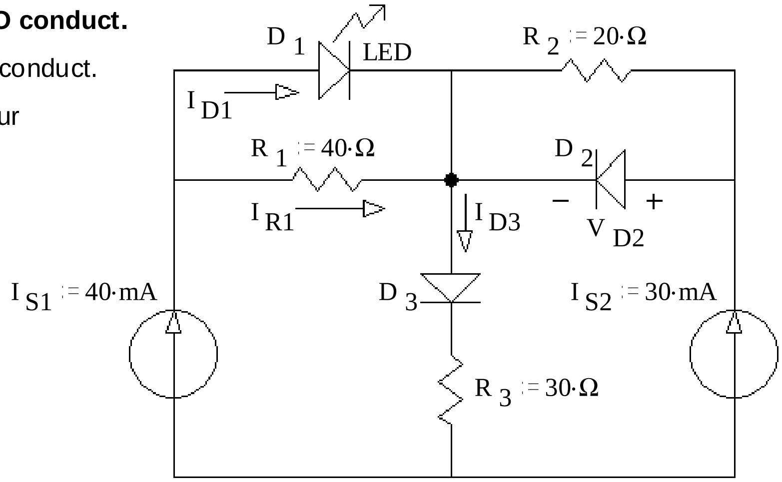
   Assume that diode D_2 does **NOT** conduct.

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

   I_{D1} = __________

   I_{D3} = __________

   V_{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.)

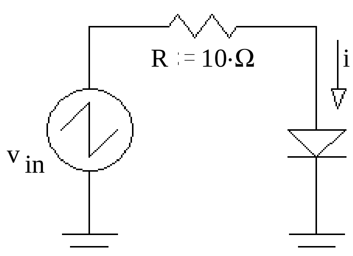
   c) Based on the numbers above, was the assumption about D_2 correct? Circle one: yes no
   How do you know? (Specifically show a value which is or is not within a correct range.)

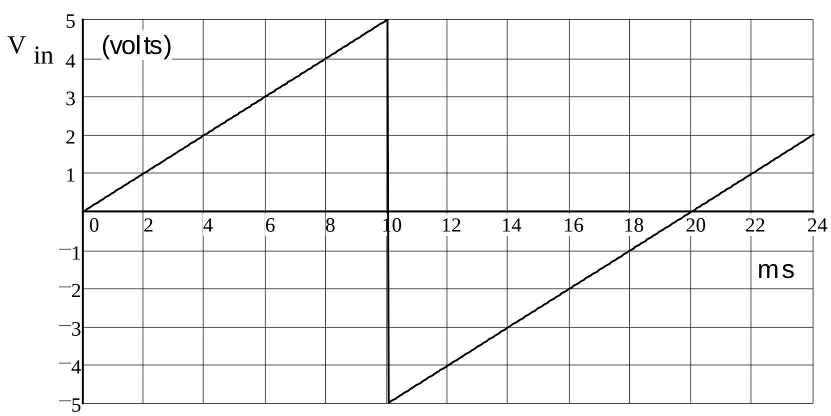
   d) Based on the numbers above, was the assumption about D_3 correct? Circle one: yes no
   How do you know? (Specifically show a value which is or is not within a correct range.)

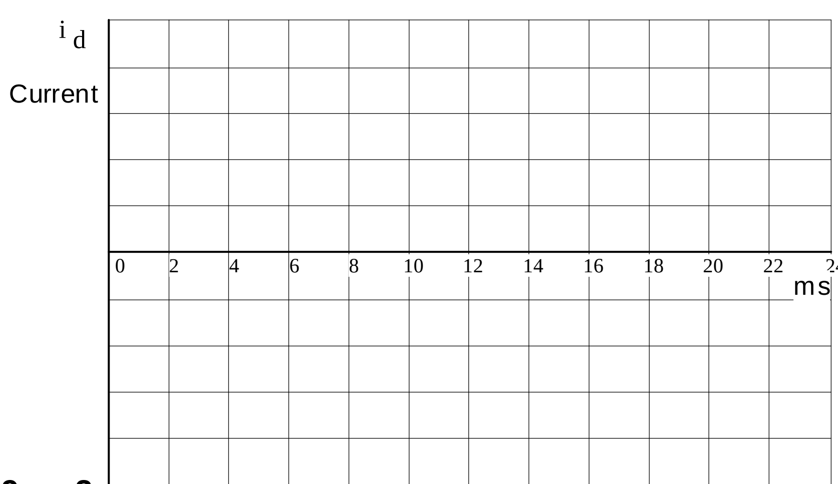
   e) Based on your answers to parts b), c) & e), which of the following need to be recalculated:

   Circle those answers that that are wrong: I_{D1} I_{D3} V_{D2}

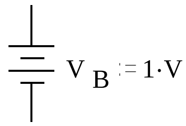
6. (12 pts) A voltage waveform is applied to the circuit shown. <u>Accurately</u> draw the diode current waveform (i_d) you expect to see. Label important times **<u>and</u>** current levels.

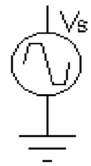


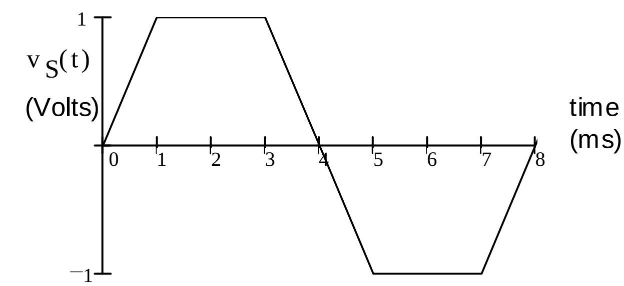




7. (34 pts) You have two input voltages to work with.
   A 1V battery and the waveform (at right).

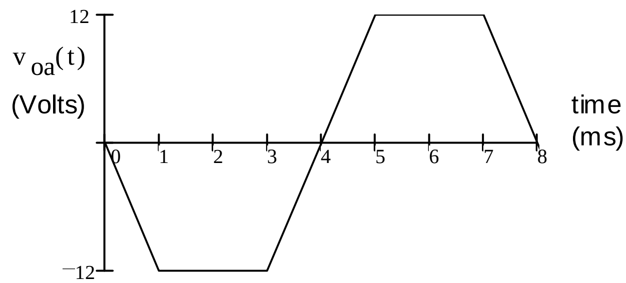




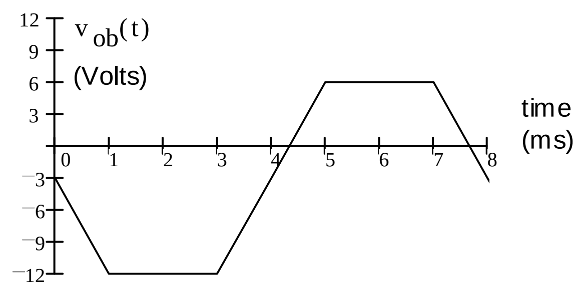


The problems below are op-amp design problems. The answer should be a schematic of a circuit showing the values of all the parts. Use reasonable resistor values (in the 100Ω to 1 MΩ range). Also show how one or both of the sources are hooked up to your circuit. Most circuits won't need both.

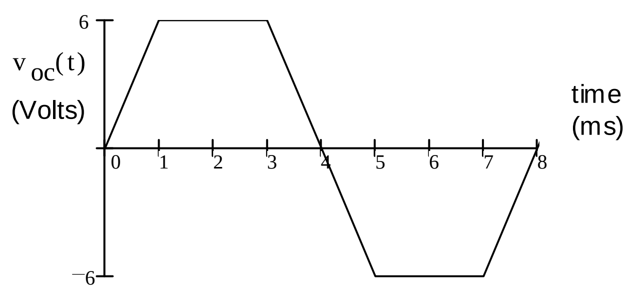
a) Design a circuit which will output the waveform at right.



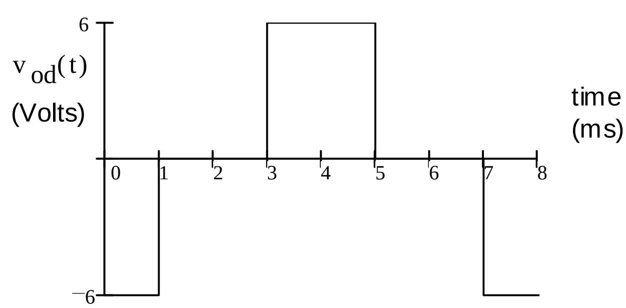
b) Design a circuit which will output the waveform at right.



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



d) Design a circuit which will output the waveform at right.
Hint: Think differentiation.



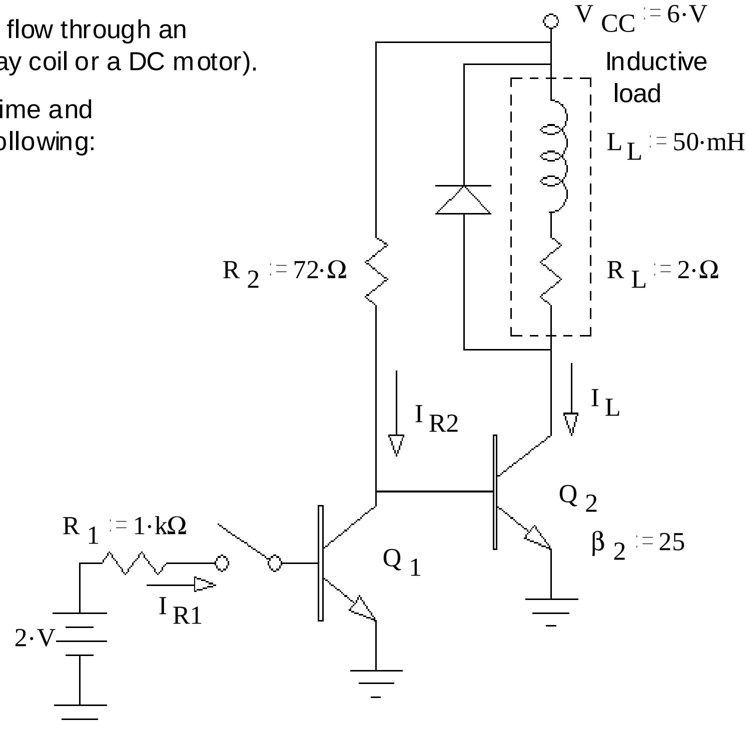
8. (26 pts) A transistor is used to control the current flow through an inductive load (in the dotted box, it could be a relay coil or a DC motor).

   a) Assume the switch has been open for a long time and transistor Q_2 is in the active region. Find the following:

   $I_L = ?$

   $V_{CE} = ?$

   $P_{Q2} = ?$



   b) Was the transistor actually operating in the active region? yes no circle one

   How do you know? (Specifically show a value which is or is not within a correct range.)

   c) Find the maximum value of R_2, so that transistor Q_2 will be in saturation.

   Use this value of R_2 for the remainder of the problem

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

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

   A) never.

   B) when the switch opens.

   C) whenever the switch is open.

   D) when the switch closes. (circle one)

   E) whenever the switch is closed.

   F) always.

   f) R_2 is that found in part c). β_1 is that found in part d). The switch is opened and closed a few times. What is the maximum diode current you expect. (Answer 0 if it never conducts.)

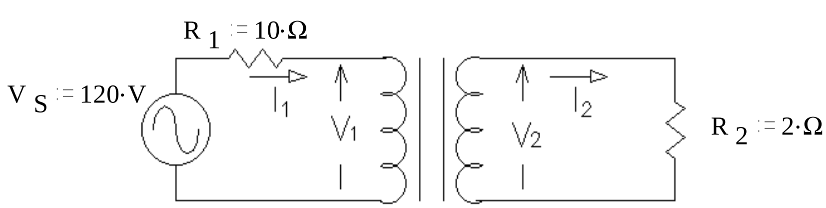
9. (17 pts) The transformer shown in the circuit below is ideal. It is rated at $150/30\ V,\ 270\ VA,\ 60\ Hz$

   Find the following: All values are RMS unless specified otherwise.

   a) The power supplied by the source.

   $P_S = ?$

   b) The power dissipated by R_2. $P_{R2} = ?$



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

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.

ECE 2210 Final

Name ______________________________

Scores:

pages 1-2 ________ / 34 pts

pages 3-4 ________ / 35 pts

pages 5-6 ________ / 34 pts

pages 7-8 ________ / 34 pts

pgs 9-10 ________ / 26 pts

page 11 ________ / 17 pts

Total ________ / 180 pts

Answers

1. a) $240\cdot mA - 160\cdot mA\cdot e^{-\frac{t}{0.113\cdot ms}}$ b) $192\cdot mA$ c) $60\cdot \mu s$

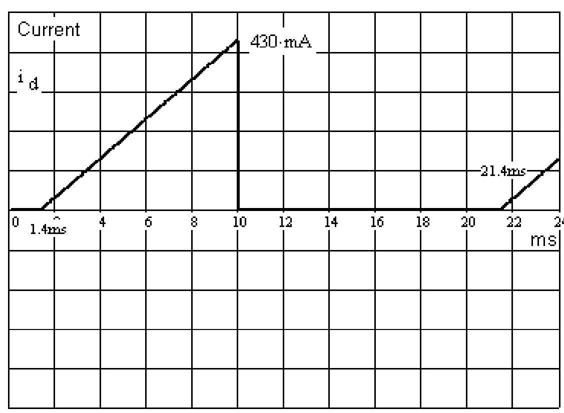
2. a) $\dfrac{\frac{1}{C}\cdot s}{s^2+\frac{1}{C\cdot R_2}\cdot s+\frac{1}{C\cdot L}}$ b) 2 c) yes, 0

3. a) $5\cdot\dfrac{(50\cdot K)\cdot(s+40)}{s^2+100\cdot s+500\cdot K+2400}$ b) 0.2 c) overdamped

4. a) $155\cdot mA$ $170\cdot mA$ $4\cdot V$ b) $-80\cdot mW$

5. a) $-10\cdot mA$ $70\cdot mA$ $0.6\cdot V$
   b) no $I_{D1} = -10\cdot mA < 0$
   c) yes $V_{D2} = 0.6\cdot V < 0.7V$
   d) yes $I_{D3} = 70\cdot mA > 0$ e) I_{D1}

6.



7. a) inverting amp with $R_f = 12R$
   b) summer with $R_f = 9R_1$ waveform is hooked to R_1 & $R_f = 3R_2$ battery + terminal is hooked to R_2 and **-** to ground
   c) non-inverting amp with $R_f = 5R$
   d) differentiator with $R_f = 6V/(C(1000V/s))$, if $C = 1\mu F$ then $R_f = 6k\Omega$

8. a) $1.84\cdot A$ $2.32\cdot V$ $4.27\cdot W$ b) yes $V_{CE} = 2.32\cdot V > 0.2\cdot V$ c) $45.7\cdot\Omega$ d) 97.6 e) D   f) $2.9\cdot A$

9. a) $240\cdot W$ b) $200\cdot W$ c) NO