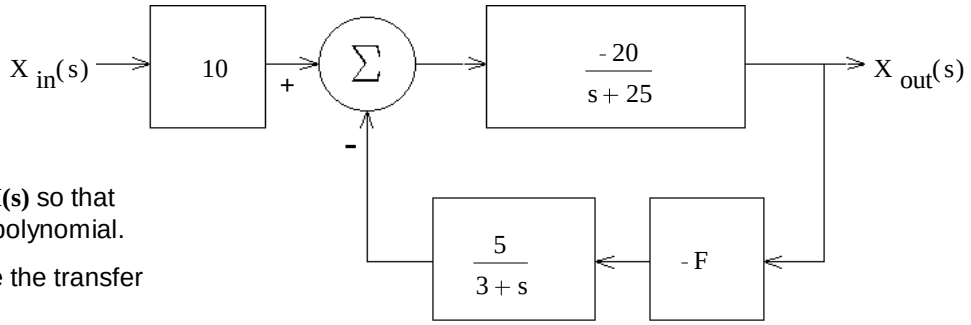
# ECE2210 Final given: Fall 10

1. (18 pts) a) A feedback system is shown in the figure. What is the transfer function of the whole system, with feedback.

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



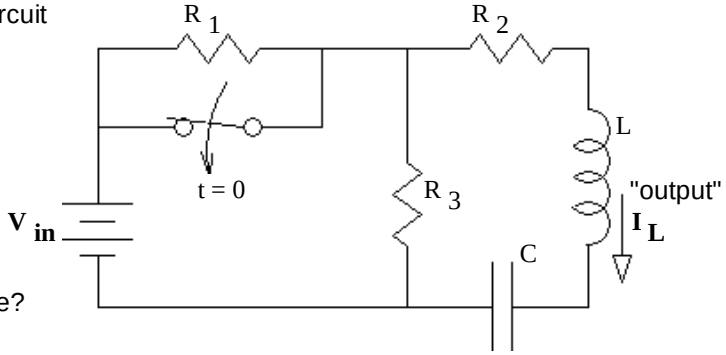

SHOW YOUR WORK
Simplify your expression for **H(s)** so that the denominator is a simple polynomial.

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

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

d) Does the transfer function have a zero? Answer no or find the s value of that zero.

2. (16 pts) a) Find the s-type transfer function of the circuit shown after time t = 0. Consider $\mathbf{I_L}$ as the "output".




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

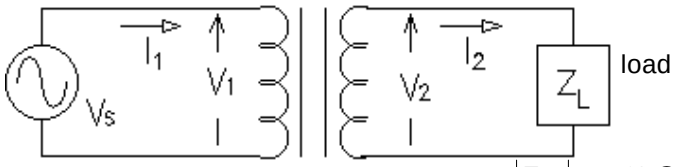
$$\mathbf{H}(s) = \frac{\mathbf{I_L}(s)}{\mathbf{V_{in}}(s)} = ?$$

b) How many zeroes does this transfer function have?

c) How many poles 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).

3. (31 pts) A transformer is rated at 360V / 120V, 0.9kVA. Assume the transformer is ideal and all voltages and currents are RMS.




a) What is the current rating of the primary?

b) What is the current rating of the secondary?

$|\mathbf{Z_L}| = 12 \cdot \Omega$

c) The secondary has 150 turns of wire. How many turns does the primary have?

pf := 80·% lagging

d) The voltage across the load, $\mathbf{V_L} := 110 \cdot V$ How big is the source voltage ($|\mathbf{V_S}|$)?

$\mathbf{V_L} := 110 \cdot V \angle 0^o$

e) The secondary load ($\mathbf{Z_L}$) has a magnitude of 12 Ω at a power factor of 80%. Find the secondary current, $\mathbf{I_2}$ (magnitude **and angle**).

pf := 80·%

h) How much average power does the load dissipate?

i) How much average power does the power source ($\mathbf{V_S}$) supply?

j) Is this transformer operating within its ratings?
How do you know? (Specifically show a values which are or are not within a correct range.)

Within range? yes no (circle one)

k) Using the given load voltage and power factor, what is the smallest load impedance magnitude that you could hook to this transformer and still operate within its ratings?

$|\mathbf{Z_{Lmin}}| = ?$

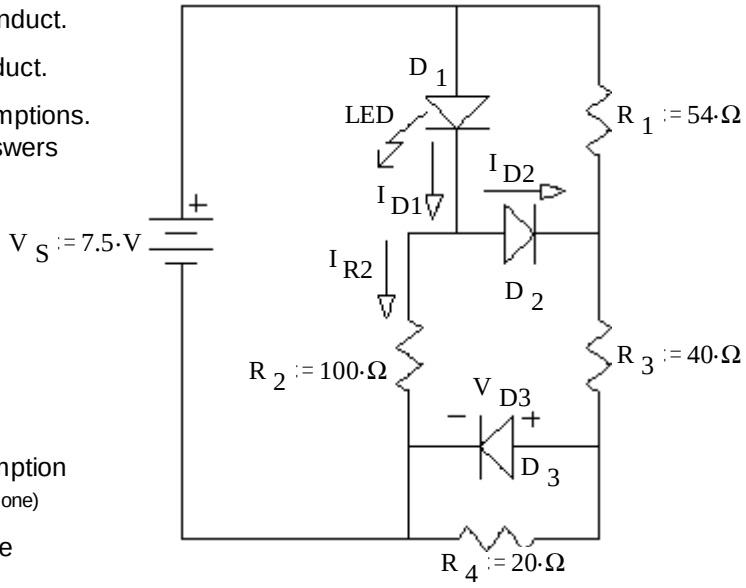
g) What is the load as seen by $\mathbf{V_S}$? (magnitude **and angle**)

l) Using the given load voltage and power factor, what is the maximum power that this transformer can deliver to the load and still operate within its ratings?

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

4. (25 pts) Assume that diodes $D_1$ and $D_2$ **DO** conduct.

   Assume that diode $D_3$ does **NOT** conduct.




   a) Find $I_{R2}$, $I_{D2}$, $I_{D1}$, & $V_{D3}$ based on these assumptions. Stick with these assumptions even if your answers come out absurd.

   $I_{R2}$ = _____

   $I_{D2}$ = _____

   $I_{D1}$ = _____

   $V_{D3}$ = _____

   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 (circle one)
   How do you know? (Show a value & range.)

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

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

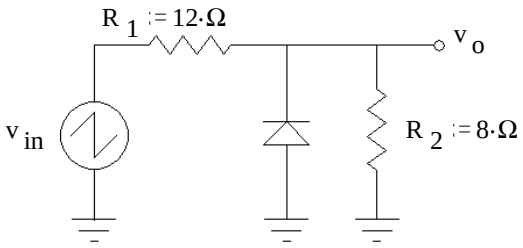
   i) The ***real*** $I_{D2} < I_{D2}$ calculated in part a.

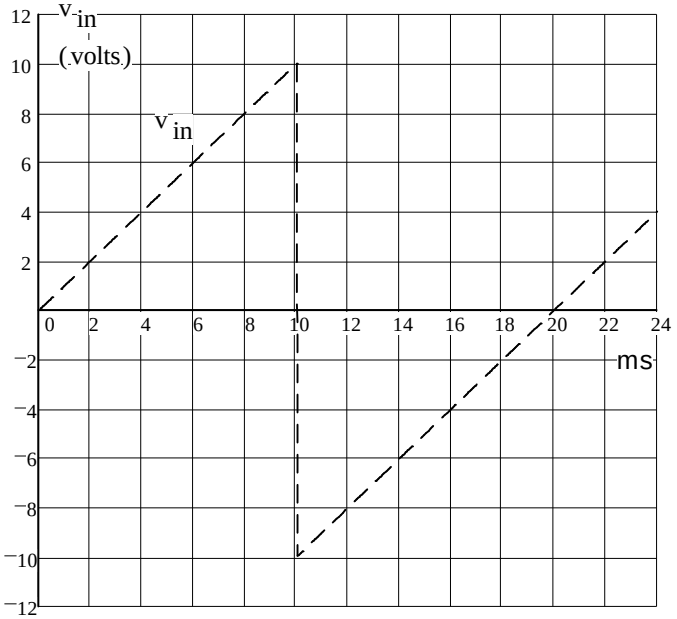
   ii) The ***real*** $I_{D2} = I_{D2}$ calculated in part a.

   iii) The ***real*** $I_{D2} > I_{D2}$ calculated in part a.

   You do not need to justify your answer.

5. (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.



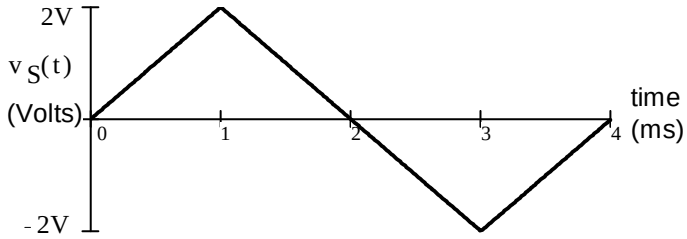




9. Do you want your grade and scores posted on the Internet? If your answer is yes, then provide some sort of alias.

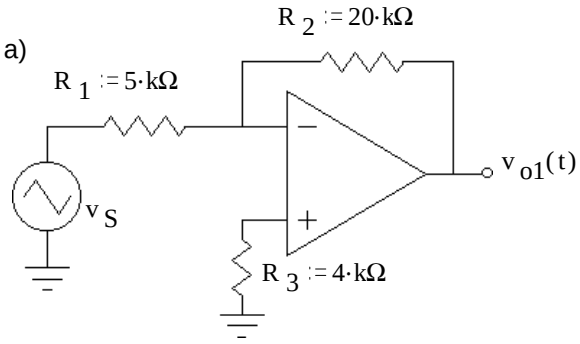
   _____ otherwise, leave blank

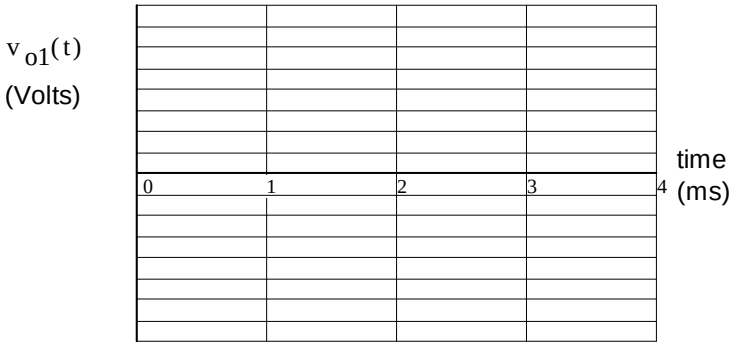
   The grades will be posted on line in pdf form in alphabetical order under the alias that you provide here. I will not post grades under your real name. It will show the homework, lab, and exam scores of everyone who answers here.

6. (27 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. All op-amps are powered by $\pm$ 12 V power supplies.

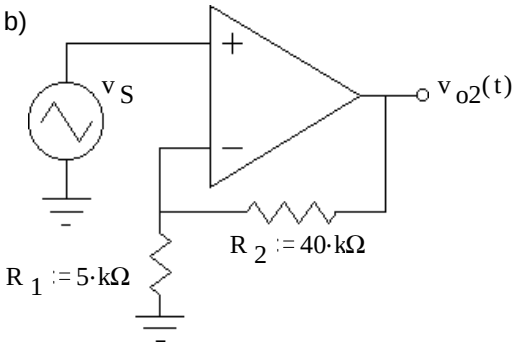


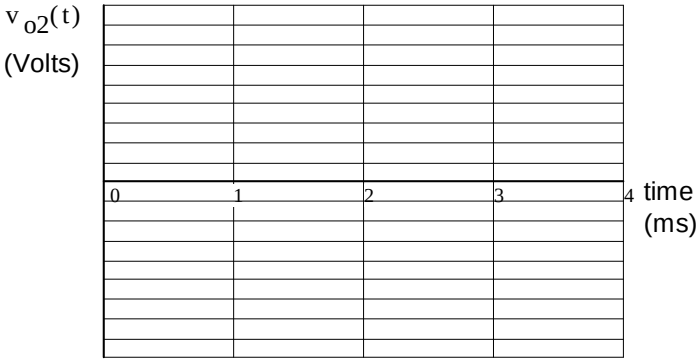

a)



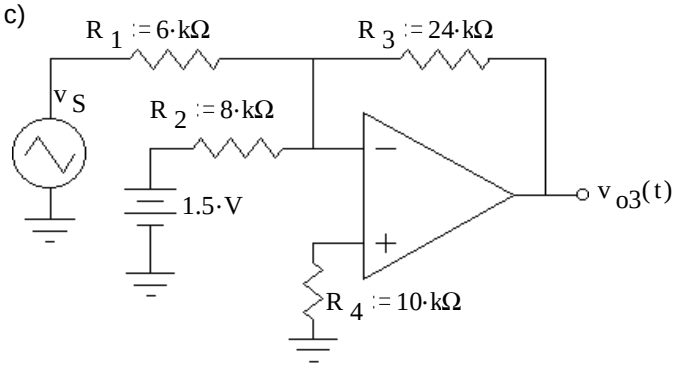



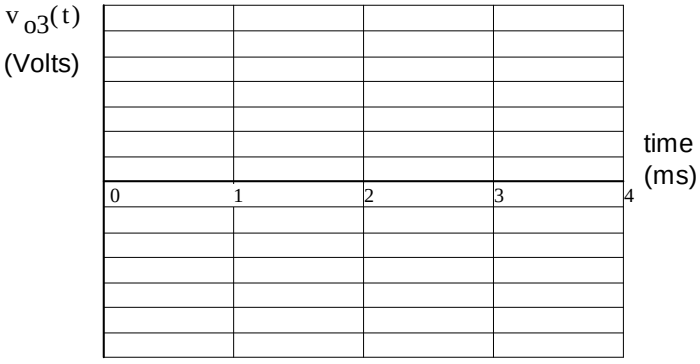

b)



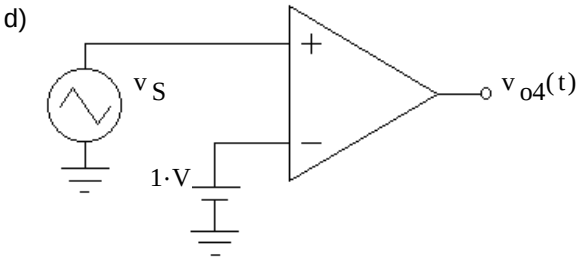



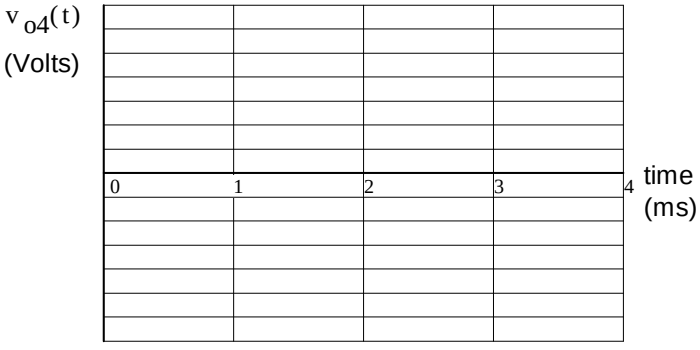

c)



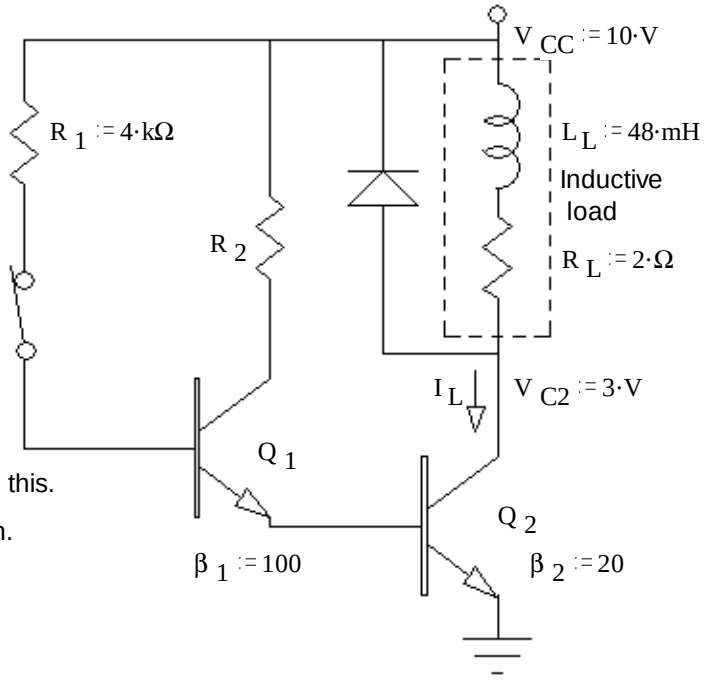

d)



## ECE2210 Final given: Fall 10 p4

7. (35 pts) A couple of transistors are used to control the current flow through an inductive load.




a) The switch has been closed for a long time. You measure the voltage at the collector of $Q_2$ to be the value shown (referenced to ground). Find the power dissipated in transistor $Q_2$. $P_{Q2} = ?$

b) $Q_1$ is in saturation, what is the value of $R_2$? You may assume that the emitter current of $Q_1$ is approximately equal to the collector current of $Q_1$. $R_2 = ?$

c) Determine if $Q_1$ actually is saturated. Show how you find this.

d) Find the minimum value $\beta_2$ so that $Q_2$ will be in saturation.

e) Find the power dissipated in transistor $Q_2$ with the $\beta$ you just calculated ($Q_2$ in saturation). $P_{Q2} = ?$

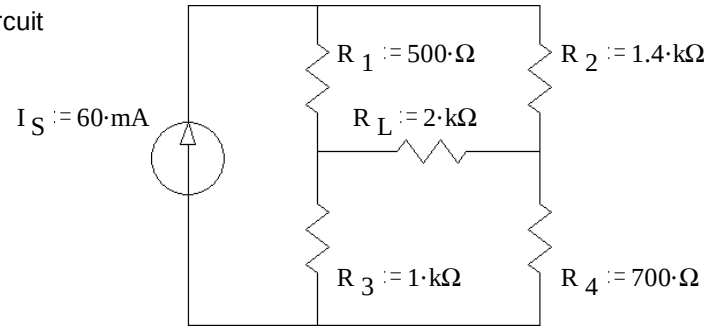
f) The diode in this circuit conducts a significant current: (circle one)

A) never. C) whenever the switch is closed. E) when the switch first opens.
B) when the switch first closes. D) always. 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.) Assume the $\beta_2$ of part d) ($Q_2$ in saturation when on).

8. (10 pts) a) Draw the Thévenin equivalent of the circuit shown and find $V_{Th}$ **only**. The load resistor is $R_L$.

You don't need to find $R_{Th}$, but you'll get 6 points extra credit if you do find the correct $R_{Th}$.




## Answers

1. a) $\dfrac{-200\cdot(s+3)}{s^2+28\cdot s+75+100\cdot F}$ b) 1.21

c) underdamped d) s = -3

2. a) $\dfrac{\frac{1}{L}\cdot s}{s^2+\frac{R_2}{L}\cdot s+\frac{1}{L\cdot C}}$ b) 1 s = 0 c) 2 $\dfrac{-\frac{R_2}{L}+\sqrt{\left(\frac{R_2}{L}\right)^2-\frac{4}{L\cdot C}}}{2}$ $\dfrac{-\frac{R_2}{L}-\sqrt{\left(\frac{R_2}{L}\right)^2-\frac{4}{L\cdot C}}}{2}$

3. a) 2.5·A b) 7.5·A c) 450 d) 330·V e) 9.17A /-36.9° f) 3.06A /-36.9°
g) 108Ω /36.9° h) 807·W i) 807·W j) No 9.17·A > 7.5·A k) 14.7·Ω l) 660·W

4. a) 55·mA 30·mA 85·mA 1.6·V b) yes $I_{D1}$ = 85·mA > 0 c) yes $I_{D2}$ = 30·mA > 0
d) no $V_{D1}$ = 1.6·V > 0.7V e) iii

5. Starts at 0V, ramps up to 4V at 10ms, then drops instantly to -0.7V where it stays until 18.25ms, Finally it ramps up through 0V at 20ms.

6. a) Inverted triangle wave that peaks at -8 and +8V.
b) Triangle wave that would peak at +18 and -18V but is clipped off at +11 and -11V.
c) Inverted triangle wave centered arround -4.5V that would peak at -12.5V but is clipped off at -11V, the positive peak is 3.5V.
d) -11V to 0.5ms, then +11V to 1.5ms, -11V from then on.

7. a) 10.5·W b) 52·Ω more accurate:52.5·Ω c) yes
d) 28 e) 0.98·W f) E g) 4.9·A 8. 17.5·V