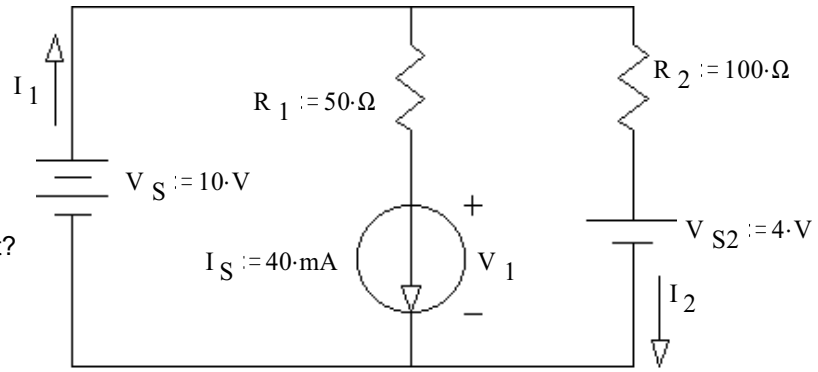
ECE2210 Final given: Spring 07

1. (16 pts)

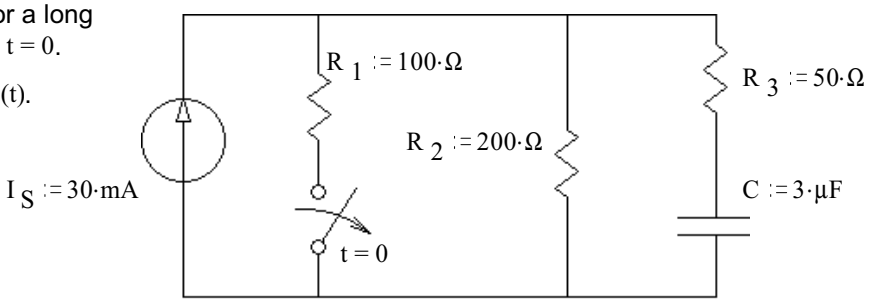
   a) Find: I_2 V_1 & I_1

   b) V_{S2} Supplies how much power to the circuit?



2. (20 pts) The switch has been closed for a long time and is opened (as shown) at time $t = 0$.

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



   b) If the switch were closed again, would the time constant be different? If yes, find the new time constant.

3. (16 pts)

   a) Find $\mathbf{V_{in}}$ in polar form.

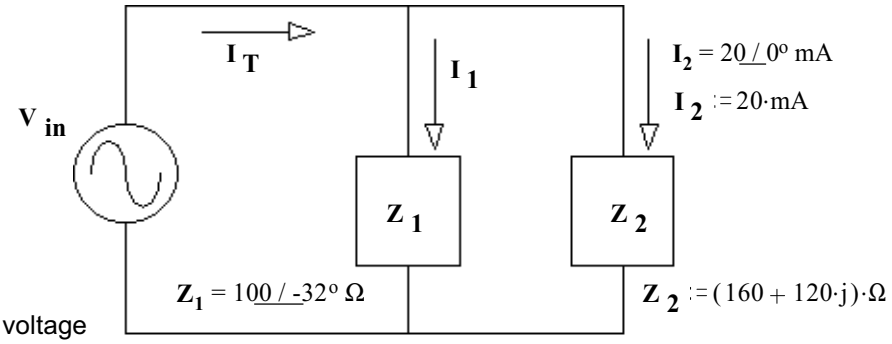
   b) Find $\mathbf{I_T}$.

   c) Circle 1:

      i) The source current leads the source voltage

      ii) The source voltage leads the source current

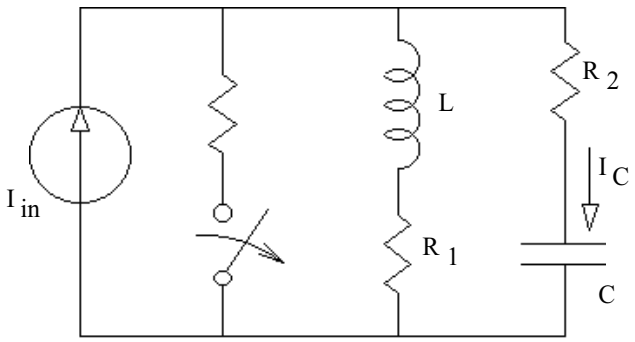
   d) By how much? I.E. what is the phase angle between the voltage and current?



4. (16 pts) a) Find the s-type transfer function of the circuit shown after the switch opens. I_{in} is the input and I_C is the "output".
   You MUST show work to get credit.
   Simplify your expression for $H(s)$ so that it is a ratio of simple polynomials.

   Hint: Since the input and the "output" are both currents, think in terms of a current divider instead the voltage divider you may be more used to.

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

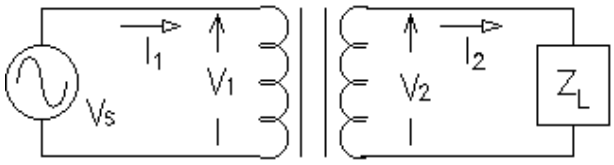


   b) Find the characteristic equation of the circuit shown.

   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.

5. (20 pts) A transformer is rated at 480V / 120V, 1.2kVA. 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?

$|\mathbf{Z_L}| := 20 \cdot \Omega$

$pf := 75 \cdot \%$ lagging

$\mathbf{V_L} := 110 \cdot V$

c) The secondary has 100 turns of wire. How many turns does the primary have?

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

e) The secondary load (Z_L) has a magnitude of 20 Ω at a power factor of 75%. Find the secondary current, $\mathbf{I_2}$ (magnitude **and angle**).

f) Find the primary current, $\mathbf{I_1}$ (magnitude **and angle**).

g) How much average power does the load dissipate?

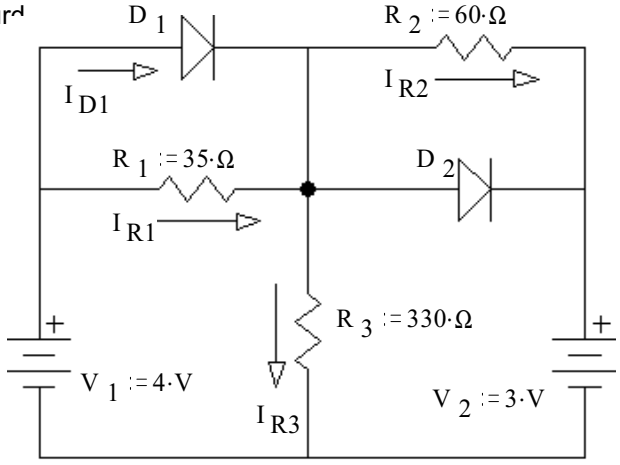
h) How much average power does the power source ($\mathbf{V_S}$) supply?

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

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

6. (18 pts) Assume that diode D_1 does conduct. Assume that diode D_2 does NOT conduct.

a) Find I_{R1}, I_{R2}, I_{R3}, & I_{D1} based on these assumptions. Stick with these assumptions even if your answers come out absurd



I_{R1} = _____

I_{R2} = _____

I_{R3} = _____

I_{D1} = _____

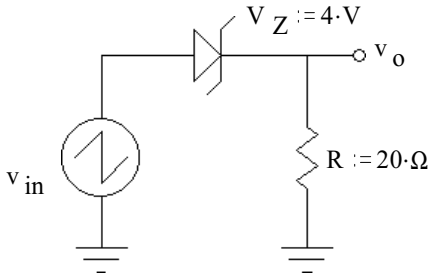
b) Based on what you found above, was the assumption about D_1 correct? (circle one) yes no

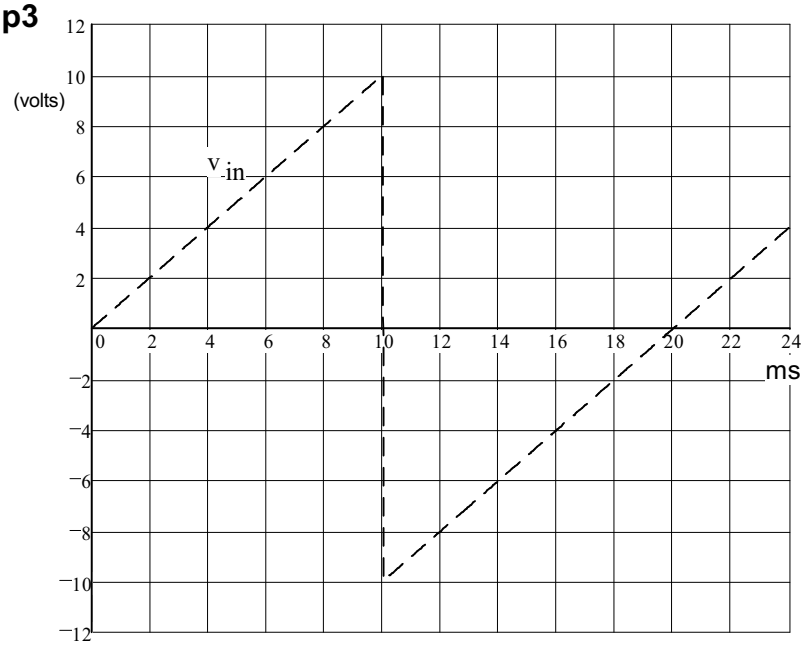
How do you know? (Specifically show a value which is or is not within a correct range.)

c) Based on what you found above, was the assumption about D_2 correct? (circle one) yes no

How do you know?

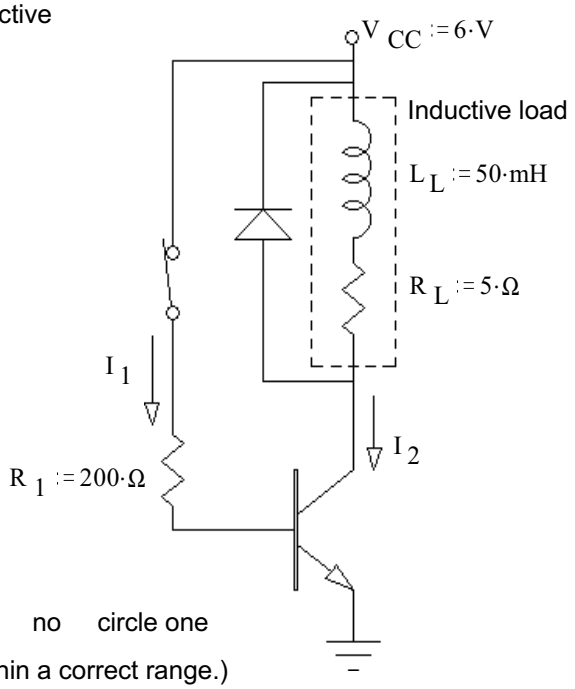
7. (15 pts) A voltage waveform (dotted line) is applied to the circuit shown.
   Accurately draw the output waveform (v_o) you expect to see. Label important times **and** voltage levels.





Label important times **and** voltage levels.

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) $\beta := 30$ Assume the switch has been closed for a long time and the transistor is in the active region, find I_2, and V_{CE} and P_Q.

   I_2 = ?

   V_{CE} = ?

   P_Q = ?

   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) What minimum β would be required to achieve saturation?

   d) You can't change the β. Find the maximum value of R_1, so that the transistor will be in saturation.
   $\beta = 30$

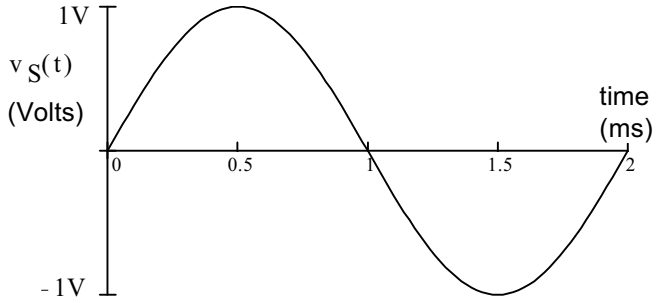
   e) The diode in this circuit conducts a significant current: (circle one)

   A) never. C) whenever the switch is open. E) whenever the switch is closed.

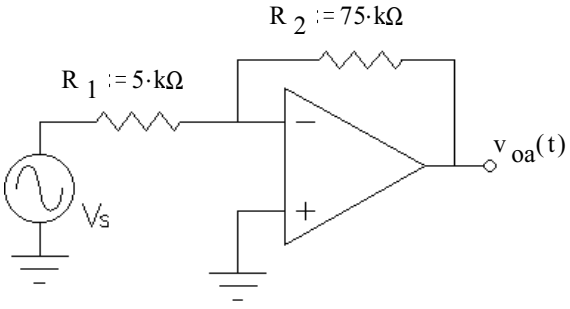
   B) when the switch opens. D) when the switch closes. F) always.

   f) R_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.)

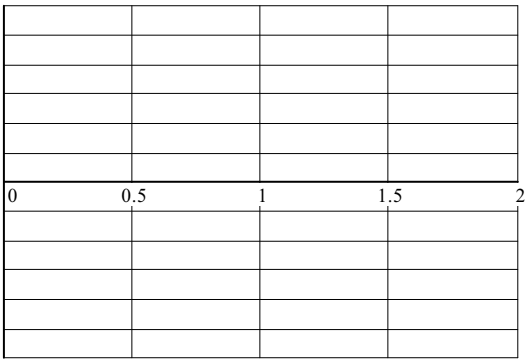
9. (25 pts) The same input signal (at right) is connected to several op-amp circuits below. Sketch the output waveform for each circuit. Clearly label important voltage levels on each output. If I can't easily make out what your peak values are, I'll assume you don't know. Don't forget to show inversions. All op-amps are powered by ± 12 V power supplies.



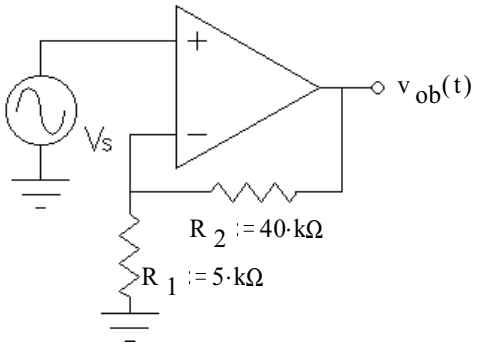
a)



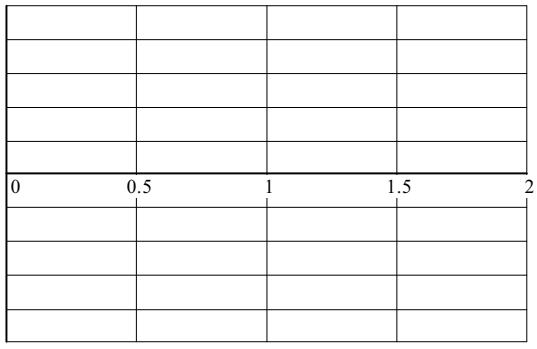
$v_{oa}(t)$
(Volts)



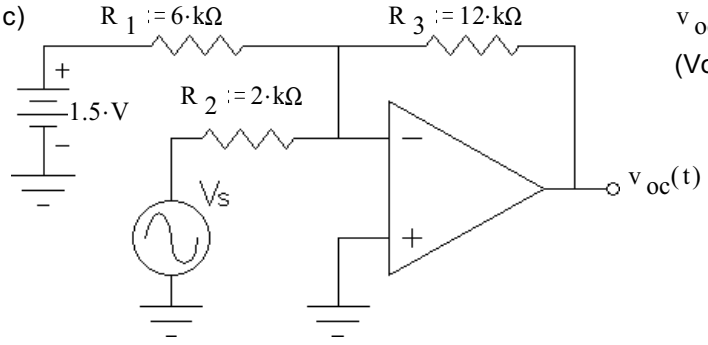
b)



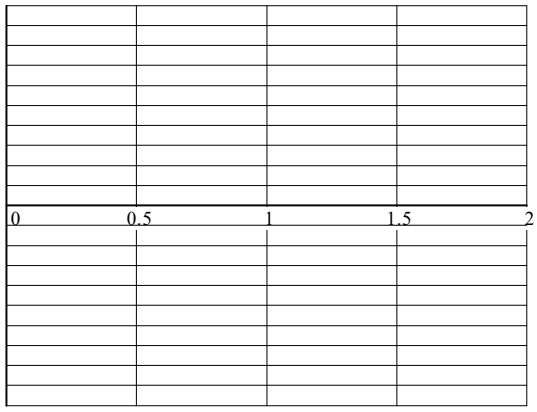
$v_{ob}(t)$
(Volts)



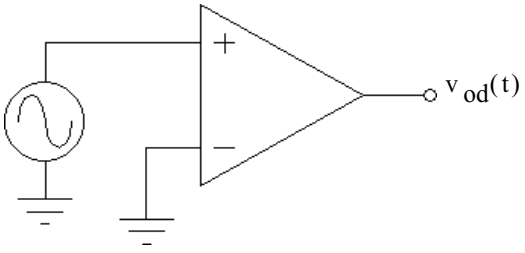
c)



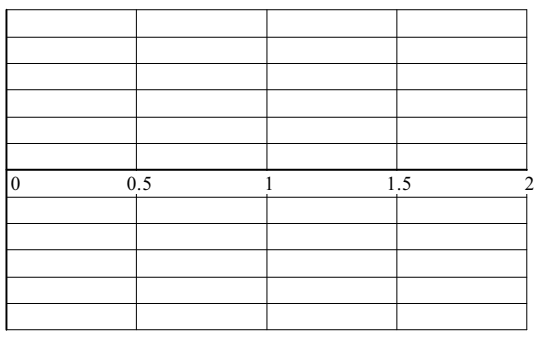
$v_{oc}(t)$
(Volts)



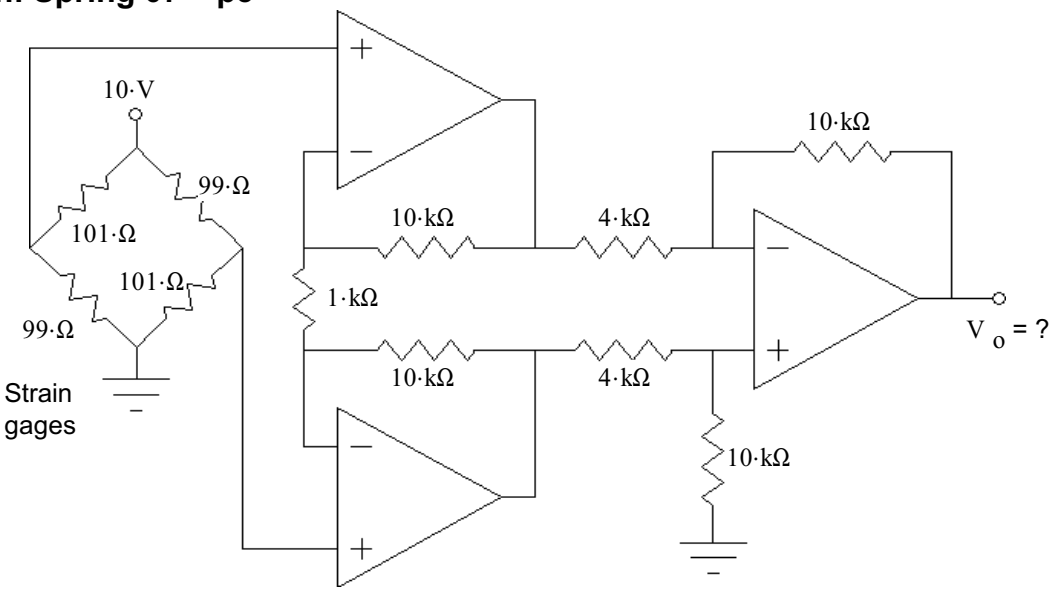
d)



$v_{od}(t)$
(Volts)



10. (8 pts) These op-amps are connected to the same supply voltages as those in the previous problem. What output do you expect?



11. Do you want your grade and scores posted on my door and on the Internet? Yes No (Circle one)

If your answer is yes, then provide some sort of alias or password: _____

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 yes here.

Answers

1. a) 60mA 8·V 100·mA

b) -240mW (negative because it absorbs power from the circuit) 2. a) $6\cdot V - 4\cdot V\cdot e^{\frac{-t}{0.75\cdot ms}}$ b) 0.35·ms

3. a) 4V / 36.9° b) 50.8mA / 47.3° c) i d) 10.4°

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

5. a) 2.5·A b) 10·A c) 400·turns d) 440·V

e) 5.5·A 41.4° f) 1.375·A 41.4°

g) 454·W h) 454·W i) 320·Ω 41.4°

6. a) 20·mA 5·mA 10·mA -5·mA

b) no $I_{D1} = -5\cdot mA < 0$

c) yes $V_{D2} = 0.3\cdot V < 0.7V$

8. a) 795·mA 2.025·V 1.61·W

b) yes $V_{CE} = 2.025\cdot V > 0.2\cdot V$

c) 43.8 d) 137·Ω e) B f) 1.16·A

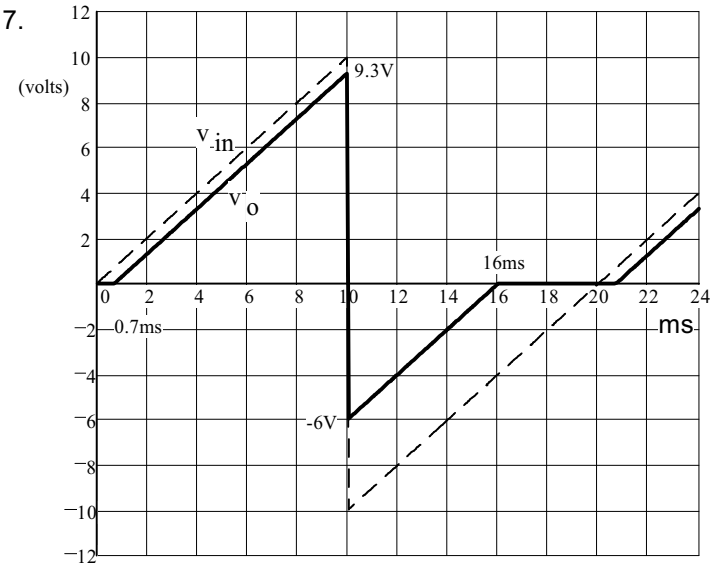
9. a) Inverted sine wave that would peak at -15V and then at +15V, but is clipped at -11V and +11V.

b) Sine wave that peaks at +9V and then at -9V.

c) Inverted 6V amplitude sine wave offset by -3V so that it peaks at -9V and then at +3V, no clipping.

d) Square wave, +11V between 0 and 1ms and then -11V between 1ms and 2ms. Extra credit if you show slew effects.

7.



10. 5.25·V