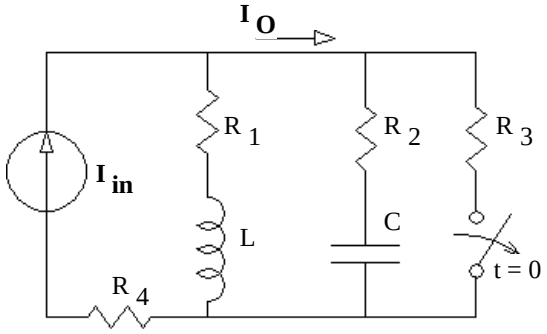
ECE 2210 Final given: Spring 19

Closed Book, Closed notes except preprinted blue sheet, Calculators OK. April 25, 2019

Show all work to receive credit. Circle answers, show units, and round off reasonably

1. (17 pts) Find the s-type transfer function of the circuit shown after the switch opens. $\mathbf{I_{in}}$ is the input and $\mathbf{I_O}$ 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.

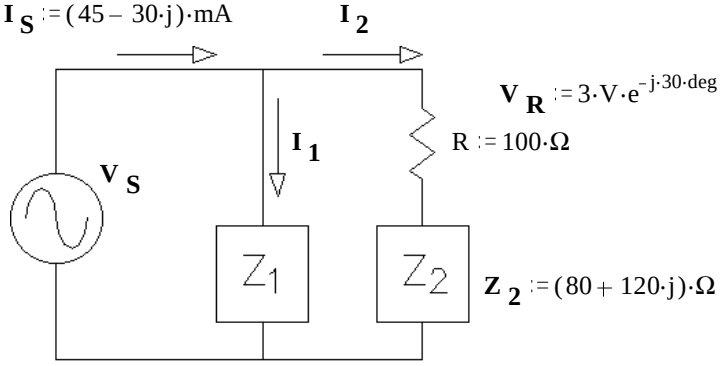


a) $\mathbf{H}(s) = ?$

b) Find the characteristic equation of the transfer function shown.

c) Does the transfer function have one or more zeros? If yes, express it (them) in terms of K_1, R_1, R_2, C, & L.

2. (20 pts) For partial credit, you must show work and/or intermediate results.



a) Find $\mathbf{I_2}$

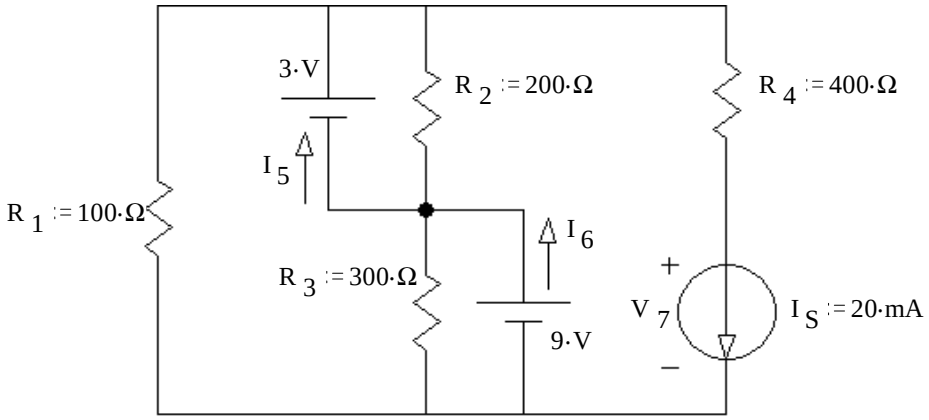
b) Find $\mathbf{V_S}$

c) Find $\mathbf{I_1}$ in polar form.

d) Find $\mathbf{Z_1}$ in any form.

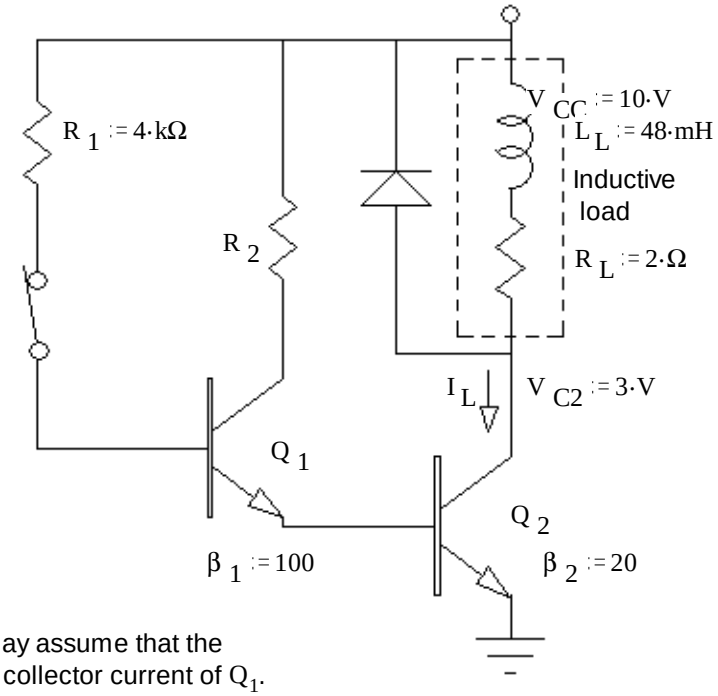
3. (20 pts)

a) Find: I_5 I_6 & V_7



b) I_S Supplies how much power to the circuit?

4. (32 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.

Is Q_1 actually saturated? Circle one: yes no

d) Find the minimum value β_2 so that Q_2 will be in saturation. β_{2min} = ?

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

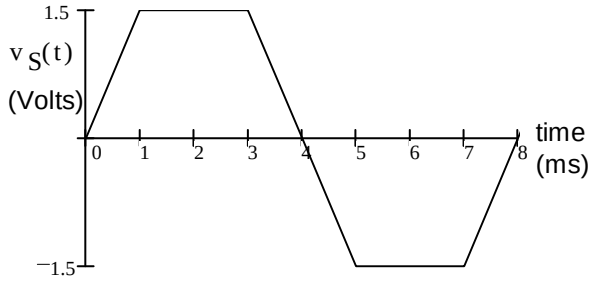
f)The diode in this circuit conducts a significant current: (circle one)

A) never. C) when the switch first opens. E) whenever the switch is open.
B) always. D) when the switch first closes. F) whenever the switch is closed.

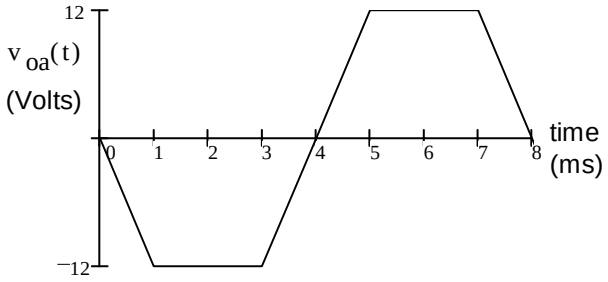
g) What is the maximum diode current you expect when the switch is cycled. (Answer 0 if it never conducts.) Assume the β_2 of part d (Q_2 in saturation when on).

5. (34 pts) You have two input voltages to work with.
A 1V battery and the waveform (at right).

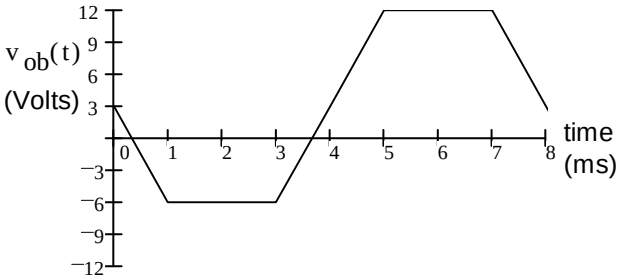
The problems below are op-amp design problems. The answer should be a schematic of a circuit showing the values of all the parts. Use reasonable resistor values (in the 100Ω to 1 MΩ range). Also show how one or both of the sources are hooked up to your circuit. Most circuits won't need both.



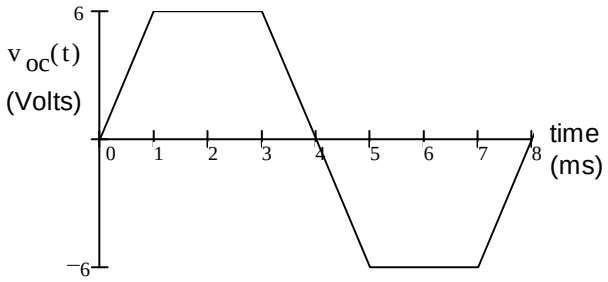
a) Design a circuit which will output the waveform at right.



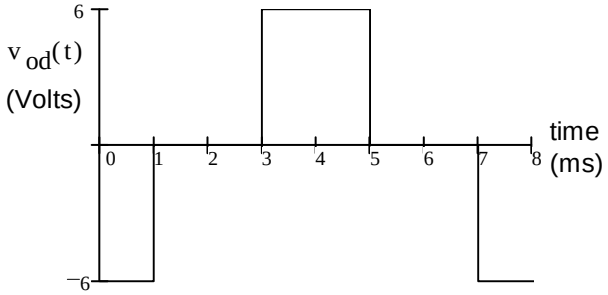
b) Design a circuit which will output the waveform at right.



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

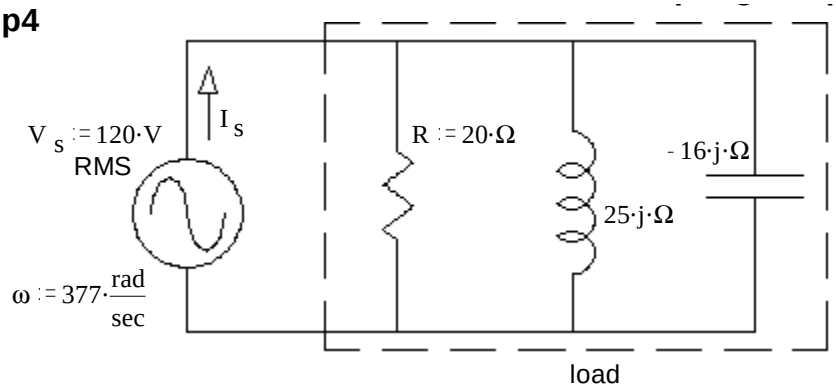


d) Design a circuit which will output the waveform at right.
Hint: Think differentiation.



e) Assume all of these circuits are built using one LM324 quad opAmp IC (the one you used in the lab). What is the minimum ± supplies you should use to power this IC (Integrated Circuit)?

6. (25 pts) R, L, & C together are the load in the circuit shown. Find the following: Be sure to show the correct units for each value.



a) The real power. P = ?

b) The reactive power. Q = ?

c) The complex power. **S** = ?

d) The apparent power. |**S**| = ?

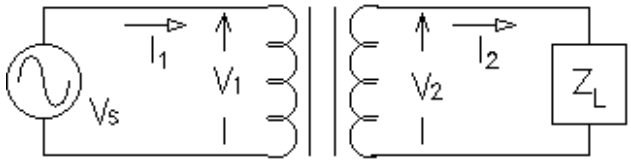
e) The RMS magnitute of the source current. $|\mathbf{I_s}|$ = ?

f) The power factor. pf = ?

g) The power factor is: i) leading ii) lagging (circle one)

h) The three components of the load are in a box which cannot be opened. Add (**draw it on the circuit above**) another component to the circuit above which can correct the power factor (make pf = 1). Show the correct component in the correct place and find its value. This component should not affect the real power consumption of the load.

7. (12 pts) A transformer is rated at 480V / 120V, 1.8kVA. Assume the transformer is ideal and all voltages and currents are RMS.



a) What is the current rating of the primary?

$|\mathbf{Z_L}| = 8 \cdot \Omega$

b) What is the current rating of the secondary?

$pf := 85 \cdot \%$ lagging

$\mathbf{V_L} := 100 \cdot V$

c) $\mathbf{V_L} := 100 \cdot V$ How big is the source voltage ($|\mathbf{V_S}|$)?

d) The secondary load (Z_L) has a magnitude of 8 Ω at a power factor of 85%. Find the secondary current, $\mathbf{I_2}$ (magnitude **and angle**).

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

8. Do you want your grade and scores posted on the Internet? If 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 or an alias that looks like a real name or u-number. The pdf spreadsheet will show the homework, lab, and exam scores of everyone who answers here.

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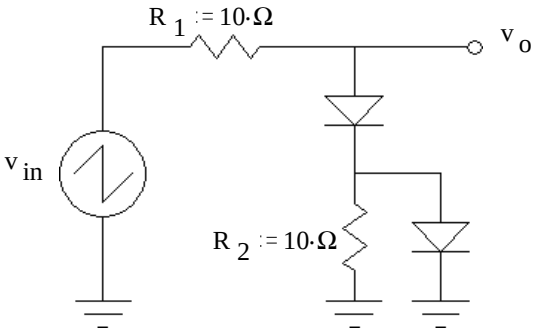
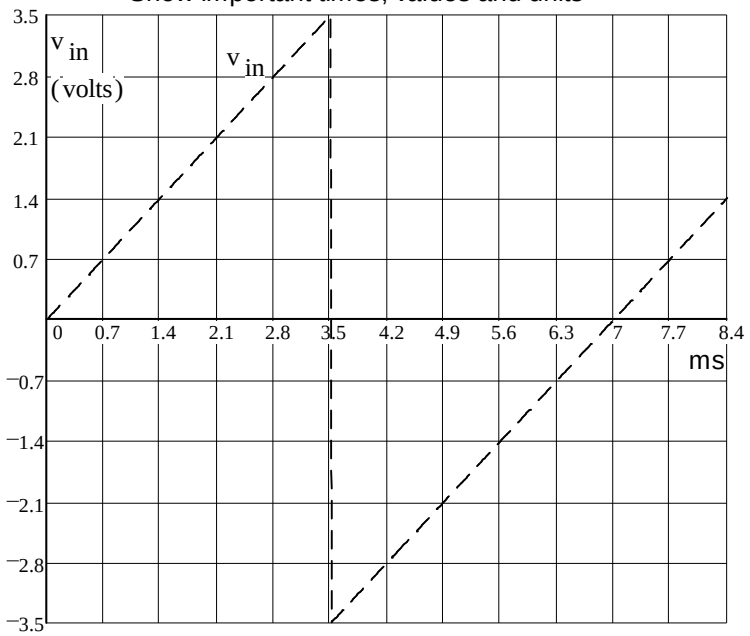
9. (20 pts) A voltage waveform (next page, dotted line) is applied to the circuit shown. Accurately draw the output waveform (v_o) you expect to see. Label important times **and** voltage levels.



Show important times, values and units



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

Answers

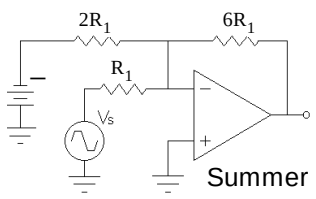
1. a) $\dfrac{s\cdot\left(s+\dfrac{R_1}{L}\right)}{s^2+\dfrac{R_2+R_1}{L}\cdot s+\dfrac{1}{L\cdot C}}$ b) $0 = s^2+\dfrac{R_2+R_1}{L}\cdot s+\dfrac{1}{L\cdot C}$ c) Yes, 0 & $-R_1/L$

2. a) 30mA /-30° b) 6.49V /3.69° c) 24.2mA /-38.3° d) 268Ω /42.0°

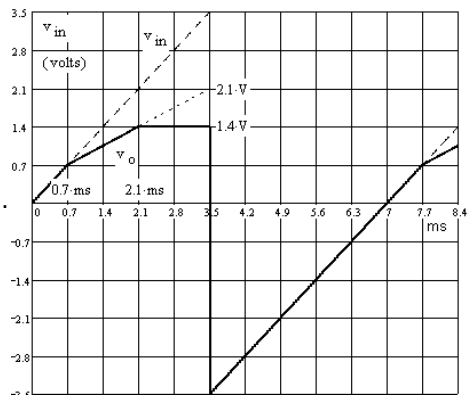
3. a) 155·mA 170·mA 4·V b) -80·mW

4. a) 10.5·W b) 52·Ω OR 52.52·Ω c) YES 100·2.15·mA> I_{C1} d) 28 e) 0.98·W f) C) g) 4.9·A

5. a) Draw inverting amp $R_f := 8\cdot R_1$ b)
   c) Draw noninverting amp $R_f := 3\cdot R_1$
   d) Draw differentiator $R_f := \dfrac{1500}{C}$
   e) ± 13 V



9.



6. a) 720·W b) -324·VAR c) (720 – 324·j)·VA
   d) 789.5·VA e) 6.58·A f)0.912 g) ii)
   h) Add a 118mH inductor in parallel with load

7. a) 3.75·A b) 15·A c) 400·V d) 12.5A /-31.8° e) 3.125A /-31.8°

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