ECE2210 Final given: Fall 14

1. (12 pts) a) Find the poles (numbers) of the following transfer function:

$$\mathbf{H}(s) = \frac{s^2 + \frac{1}{R\cdot\left(C_1 + C_2\right)}\cdot s + \frac{1}{L\cdot C_1}}{s^2 + \frac{R}{L}\cdot s + \frac{1}{L\cdot C_1}}$$

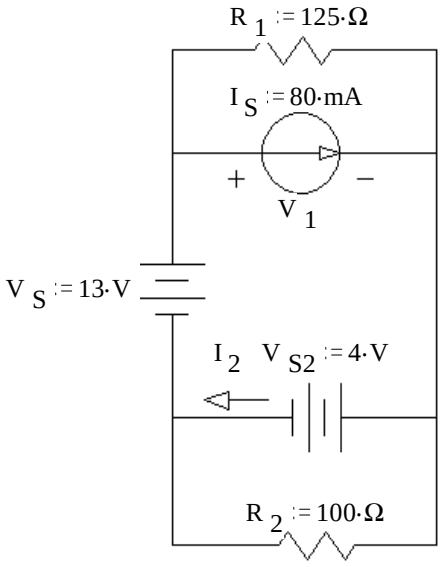
Where: $R := 50\cdot\Omega$ $L := 8\cdot mH$ $C_1 := 0.2\cdot\mu F$ $C_2 := 0.1\cdot\mu F$

b) This system represented by this transfer function is: (circle one)

i) underdamped ii) critically damped iii) overdamped iv) impossible to tell

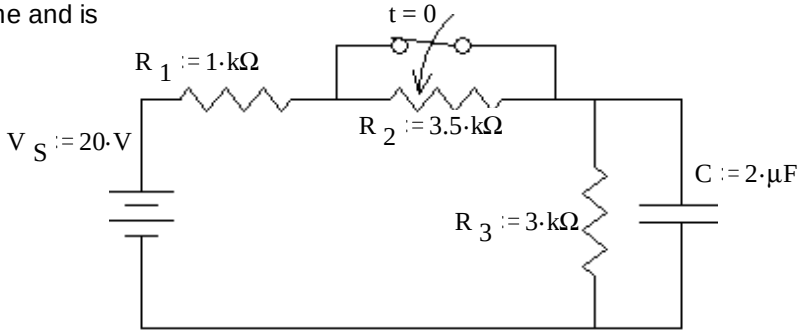
c) What value of C_1 would make this system critically damped?

2. (18 pts) a) Find: V_1 & I_2



b) I_S Supplies how much power to the circuit?

3. (18 pts) The switch has been open for a long time and is closed (as shown) at time $t = 0$.
Find the complete expression for $v_C(t)$.



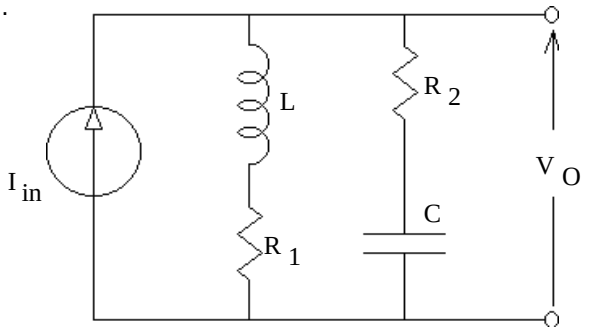
4. (14 pts) a) Find the s-type transfer function of the circuit shown.

I_{in} is the input and V_O is the "output".

You MUST show work to get credit.
Simplify your expression for $\mathbf{H}(s)$ so that the denominator is a simple polynomial in standard form.

Hint: The "output" is a voltage and the input is a current. What is voltage over current?

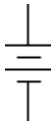
$\mathbf{H}(s)$ = ?

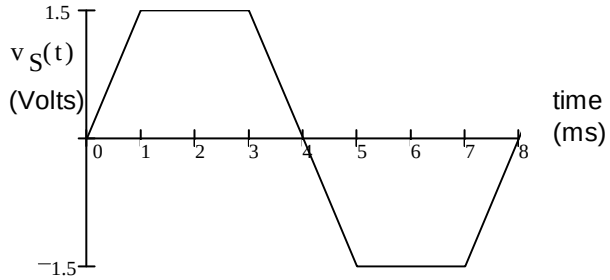


b) How many zeroes does the transfer function have?

5. On last page

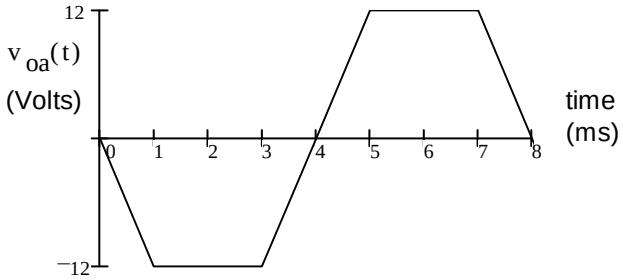
6. (34 pts) You have two input voltages to work with.
A 1V battery and the waveform (at right).



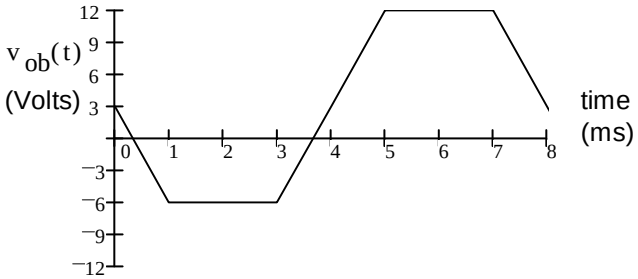


The problems below are op-amp design problems. The answer should be a schematic of a circuit showing the values of all the parts. Use reasonable resistor values (in the 100Ω to 1 MΩ range). Also show how one or both of the sources are hooked up to your circuit. Most circuits won't need both.

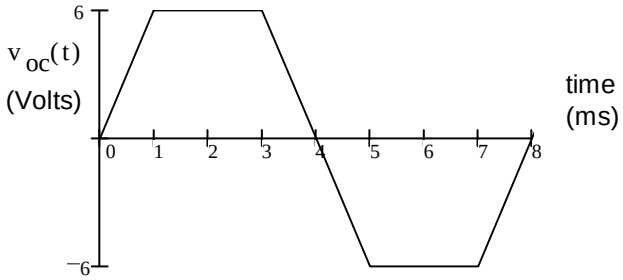
a) Design a circuit which will output the waveform at right.



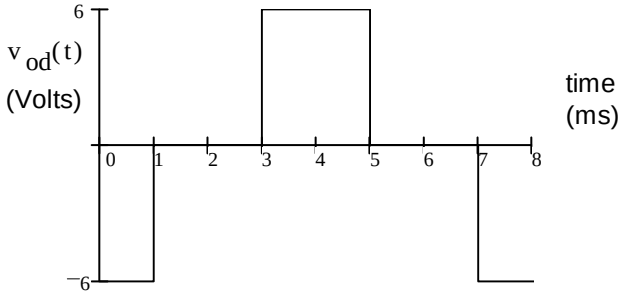
b) Design a circuit which will output the waveform at right.



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

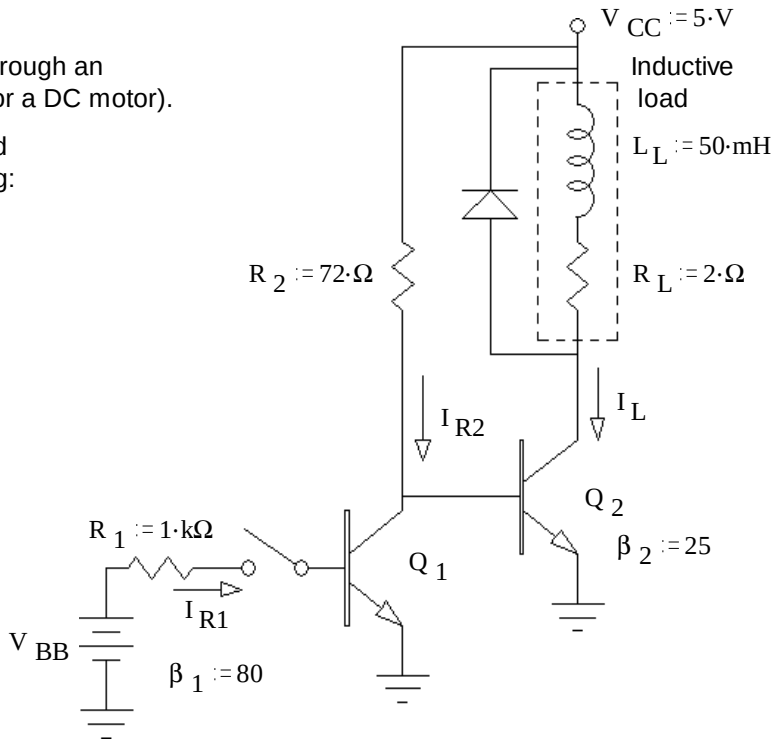


d) Design a circuit which will output the waveform at right.
Hint: Think differentiation.



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)?

7. (28 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 the transistor is in the active region. Find the following:
I_L = ? V_{CE} = ? P_Q = ?

b) Was the transistor actually operating in the active region? yes no circle one yes
How do you know? (Specifically show a value which is or is not within a correct range.)

c) When the switch is open, you would like transistor Q_2 to saturate.
What minimum β_2 would be required to achieve saturation?

d) Unfortunately, you can't find a replacement Q_2. So $\beta_2 = 25$
Find the maximum value of R_2, so that transistor Q_2 will be in saturation.

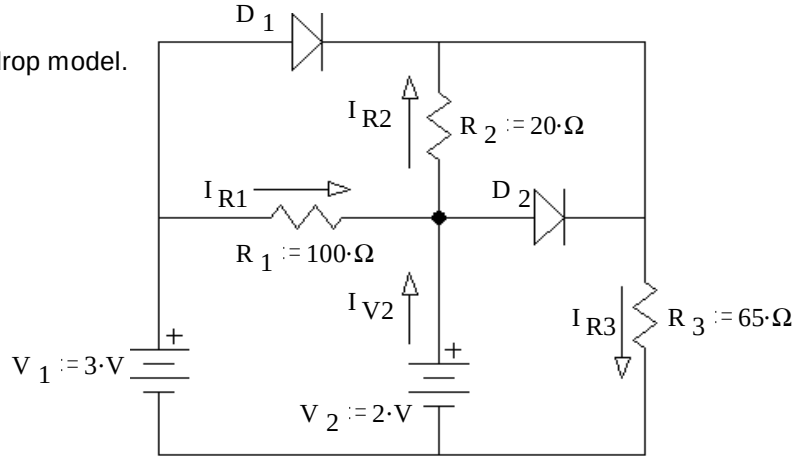
Use this value of R_2 for the remainder of the problem

e) When the switch is closed, you would like transistor Q_1 to saturate.
What minimum V_{BB} would be required to achieve saturation? $\beta_1 = 80$

f) 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. E) whenever the switch is closed. F) always. (circle one)

g) 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.)

8. (20 pts) In the circuit shown, use the constant-voltage-drop model.



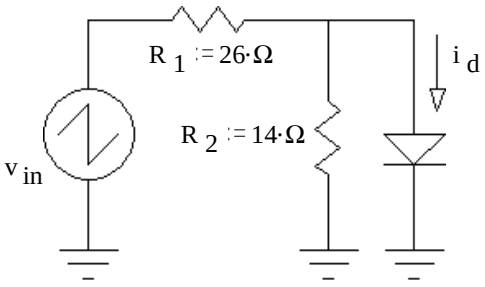
a) Assume that diode D_1 does NOT conduct.
Assume that diode D_2 does conduct.

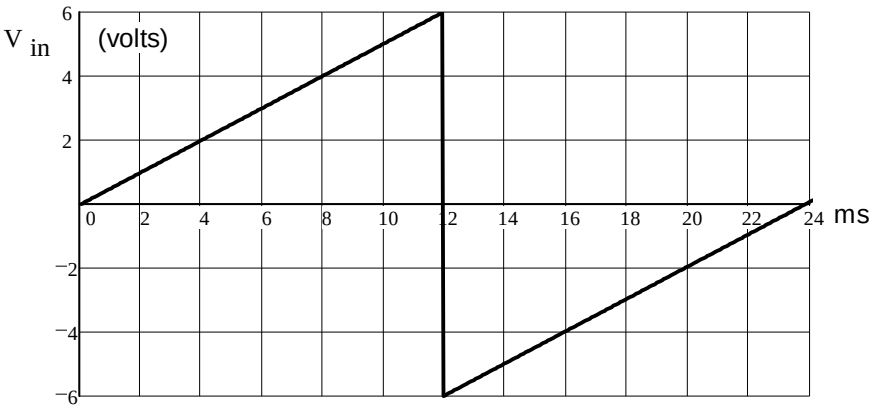
Find I_{R1}, I_{R2}, I_{R3}, & I_{V2},based on these assumptions. Stick with these assumptions even if your answers come out absurd. Hint: think in nodal voltages.
I_{R1}= ? I_{R2}= ? I_{R3}= ? I_{V2}= ?

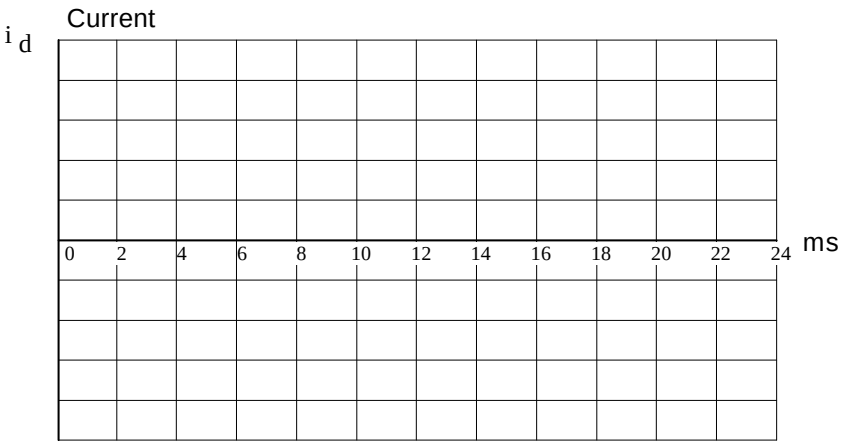
b) Based on your numbers above, does it look like the assumption about D_1 was correct? yes no
(circle one)
How do you know? (Specifically show a value which is or is not within a correct range.)

c) Based on your numbers, does it look like the assumption about D_2 was correct? yes no
(circle one)
How do you know? (Specifically show a value which is or is not within a correct range.)

10. (16 pts) A voltage waveform is applied to the circuit shown. Accurately draw the diode current waveform (i_d) you expect to see. Label important times **and** current levels.







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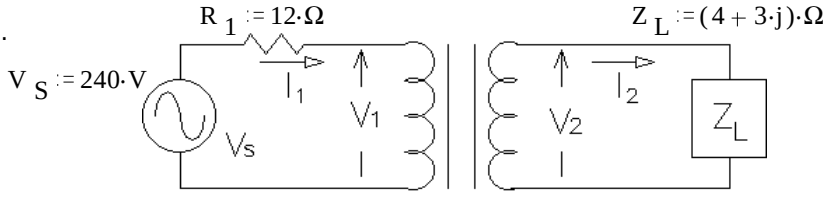
5. (20 pts) The transformer shown in the circuit below is ideal. It is rated at 480/120 V, 1.2 kVA, 60 Hz

All values are RMS unless specified otherwise.

Find the following:

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



b) The secondary current (magnitude). $|\mathbf{I_2}|$ = ?

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

d) The complex power (P and Q) used by the load. $\mathbf{S_L}$ = ?

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

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

_____ Folder number _____
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.

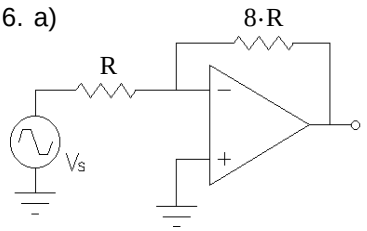
Answers

1. a) $-3125 \pm 24800 \cdot j$ b) i) c) $12.8 \cdot \mu F$ 2. a) $9 \cdot V$ $112 \cdot mA$ b) $-720 \cdot mW$ 3. $15 \cdot V - 7 \cdot V \cdot e^{-\frac{t}{1.5 \cdot ms}}$

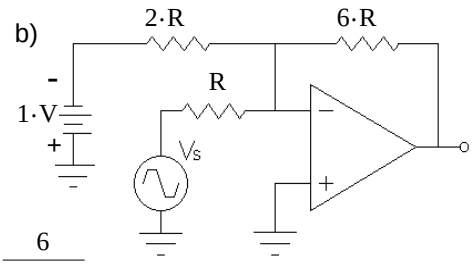
4. a) $\dfrac{R_2 \cdot s^2 + \left(\dfrac{R_2 \cdot R_1}{L} + \dfrac{1}{C}\right) \cdot s + \dfrac{R_1}{L \cdot C}}{s^2 + \dfrac{R_2 + R_1}{L} \cdot s + \dfrac{1}{L \cdot C}}$ b) 2 5. a) $2.67 \cdot A$ b) $10.7 \cdot A$ c) $53.4 \cdot V$ d) $(456 + 342 \cdot j) \cdot VA$

e) NO $I_{1max} = 2.5 \cdot A > I_1$

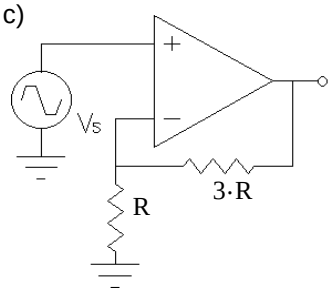
6. a)



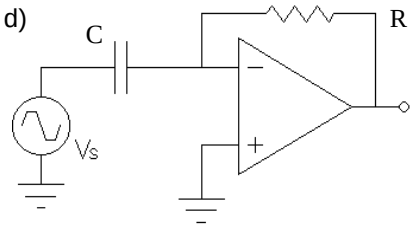
b)



c)



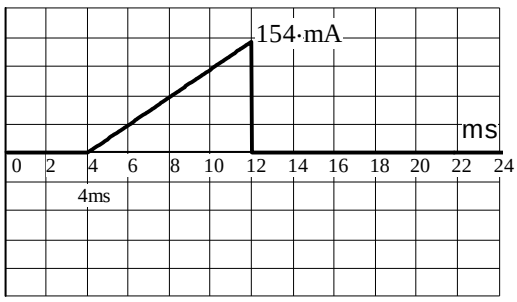
d)



$R := \dfrac{6}{C \cdot 1500}$

e) ± 13 V

10. i_d



7. a) $1.49 \cdot A$ $2.01 \cdot V$ $3 \cdot W$ b) yes $2.01 \cdot V > 0.2 \cdot V$

c) 40.2 d) $44.8 \cdot \Omega$ e) $2.04 \cdot V$ f) D) g) $2.4 \cdot A$

8. a) $10 \cdot mA$ $35 \cdot mA$ $20 \cdot mA$ $10 \cdot mA$ b) no $1.7 \cdot V > 0.7V$

 c) no $-15 \cdot mA < 0$