ECE2210 Final given: Spring 10

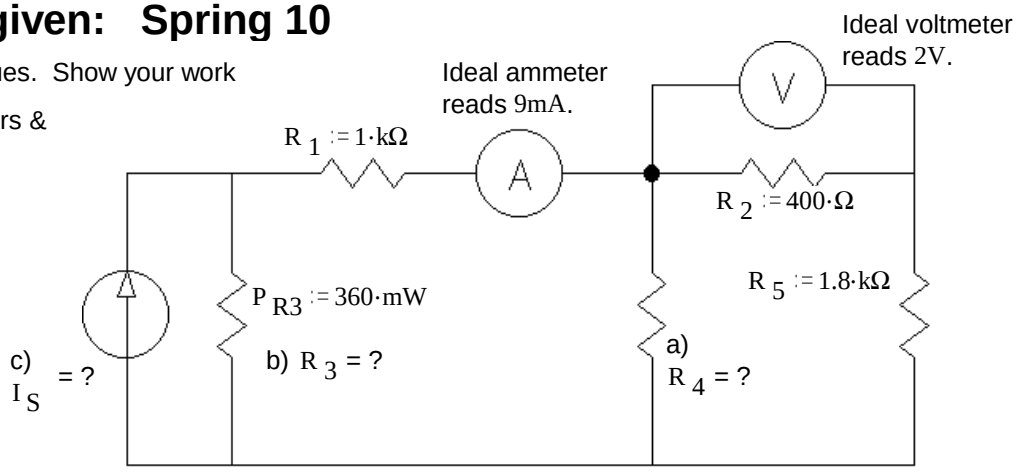
1. (21 pts) Find the resistor values. Show your work

Note: feel free to show answers & work right on the schematic

a) R_4 = ?

b) R_3 = ?

c) I_S = ?

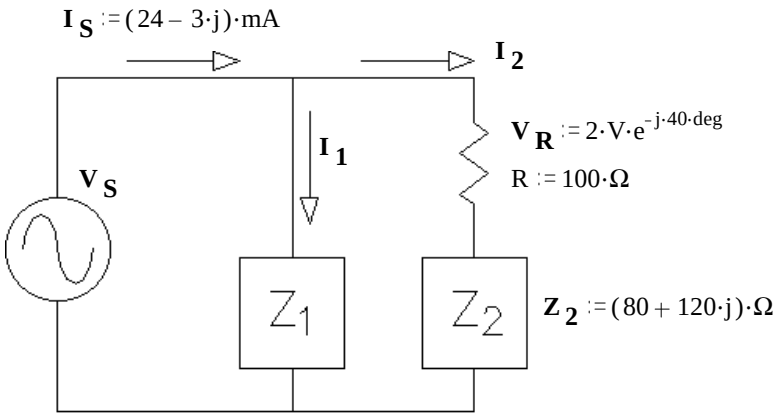


2. (17 pts) For partial credit, you must show work and/or intermediate results.

a) Find $\mathbf{I_2}$

b) Find $\mathbf{V_S}$

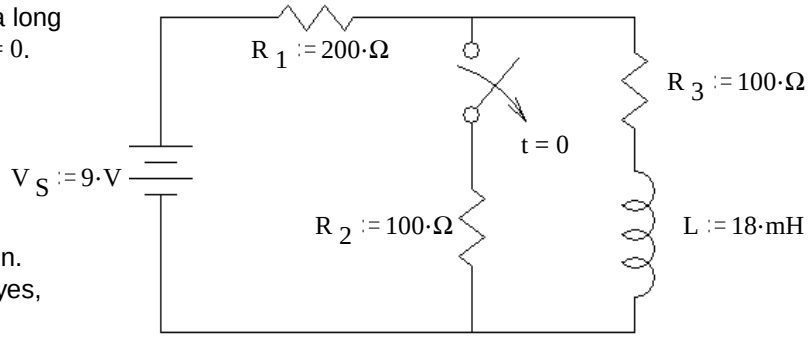
c) Find $\mathbf{I_1}$ in polar form.



3. (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 $i_L(t)$.

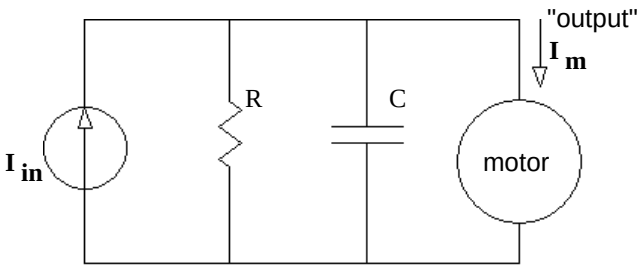
b) At some time the switch is closed again. Is the time constant different now? If yes, find the new time constant.



4. (14 pts) a) Find the s-type transfer function of the circuit shown. Consider the motor current ($\mathbf{I_m}$) as the "output".

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

$$\mathbf{H}(s) = \frac{\mathbf{I_m}(s)}{\mathbf{I_{in}}(s)} = ?$$



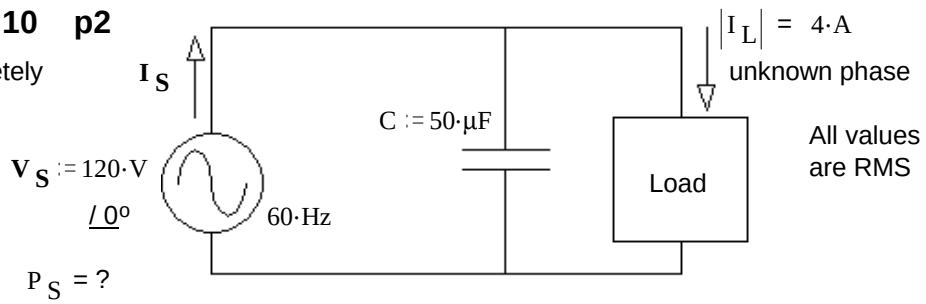
The motor may be modeled as a resistor in series with an inductor, like this:

b) How many poles does this transfer function have?

c) How many zeroes does this transfer function have?

If it has 1 or more, express them (probably in terms of R_1, R_2, L and C).

5. (21 pts) An capacitor is used to completely correct the power factor of a load.



Find the following:

a) The power consumed by the load. P_L = ?

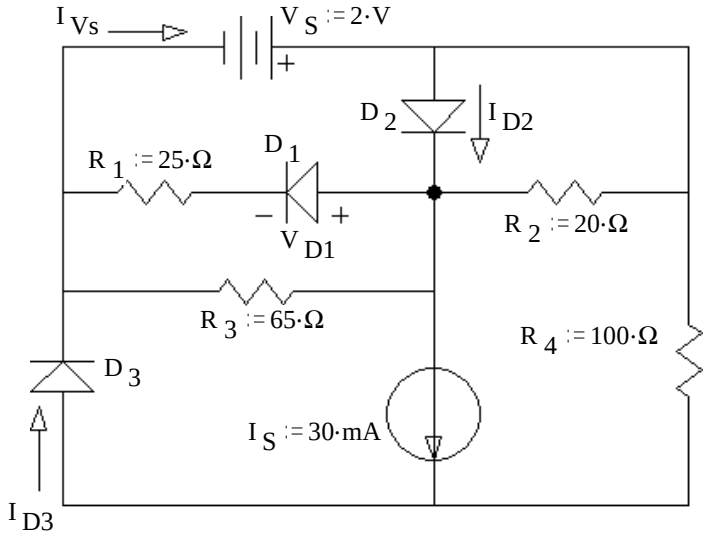
b) The power supplied by the source. P_S = ?

c) The source current (magnitude and phase). I_S = ?

d) The load can be modeled as 2 parts in series. Draw the model and find the values of the parts.

6. (22 pts) Assume that diode D_1 does **NOT** conduct.

Assume that diodes D_2 and D_3 **DO conduct.**



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

V_{D1} = _____

I_{D2} = _____

I_{D3} = _____

I_{Vs} = _____

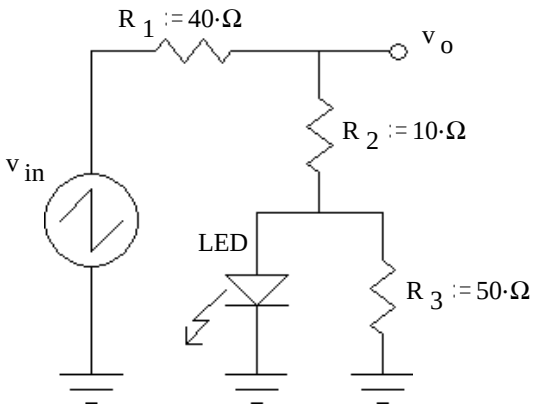
b) Based on the numbers above, was the assumption about D_1 correct? Circle one: yes no

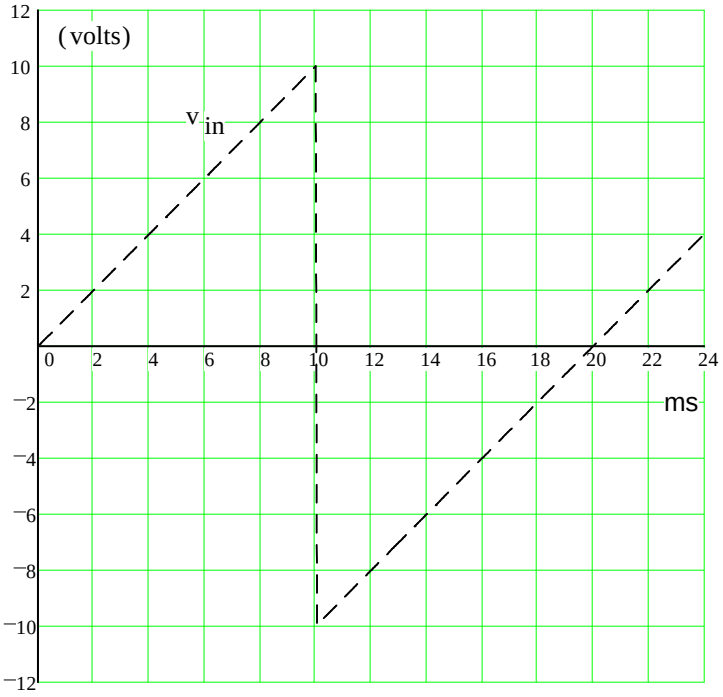
How do you know? (Specifically show a value which is or is not within a correct range.)

c) Based on the numbers above, was the assumption about D_2 correct? yes no How do you know?

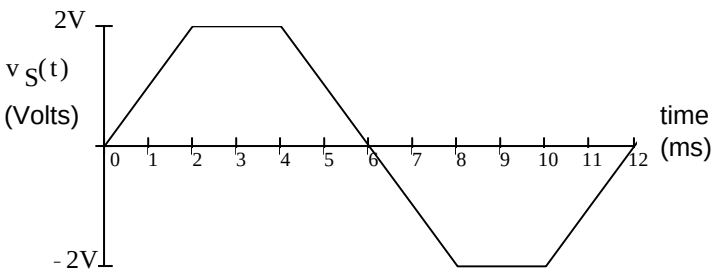
d) Based on the numbers above, was the assumption about D_3 correct? yes no How do you know?

7. (17 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.

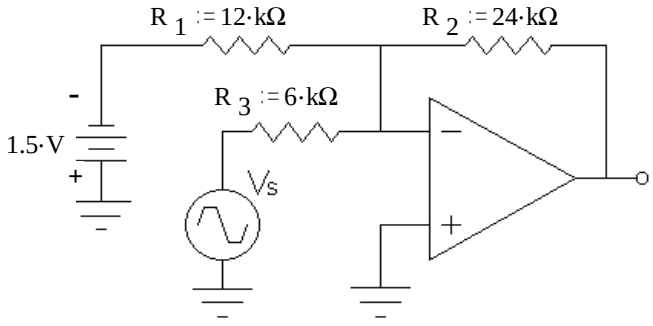


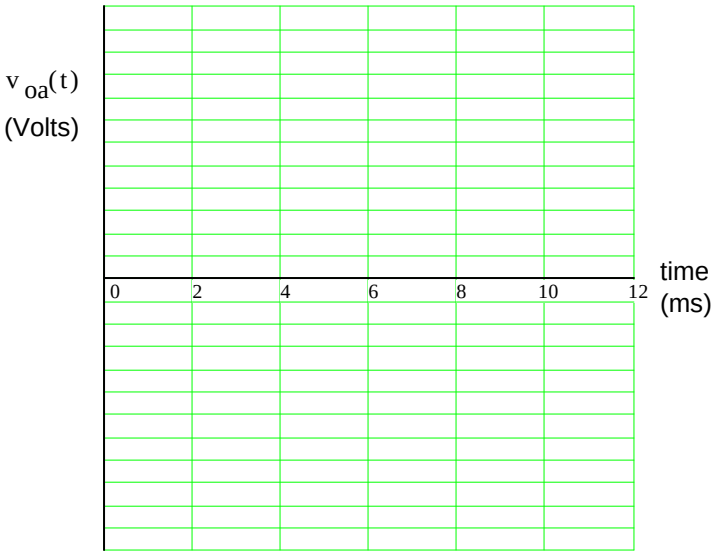


8. (20 pts) The same input signal (at right) is connected to the op-amp circuits below. Sketch the output waveform for each circuit. Clearly label important voltage levels on each output so that I can tell that you know. The op-amp is connected to +10V & -10V power supplies.

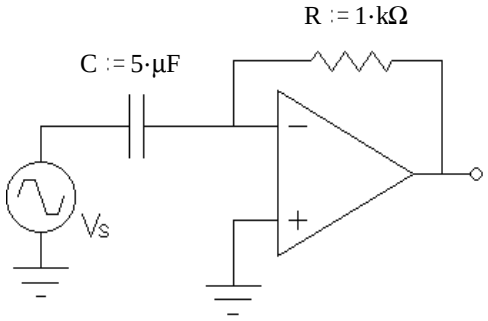


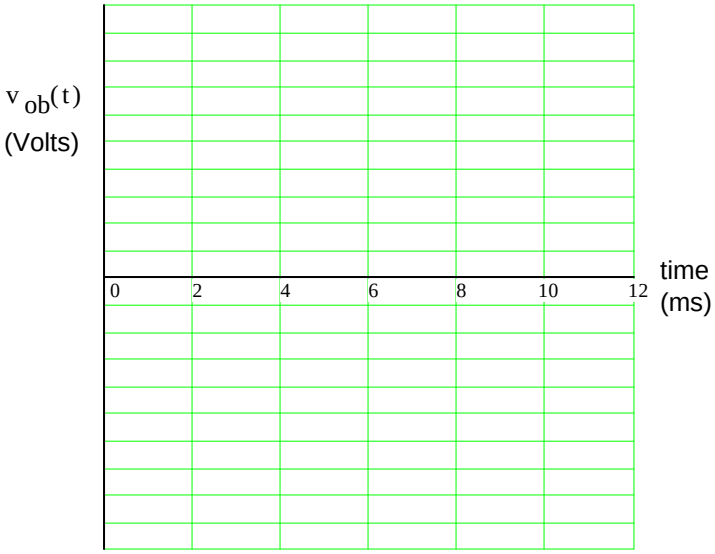
a)



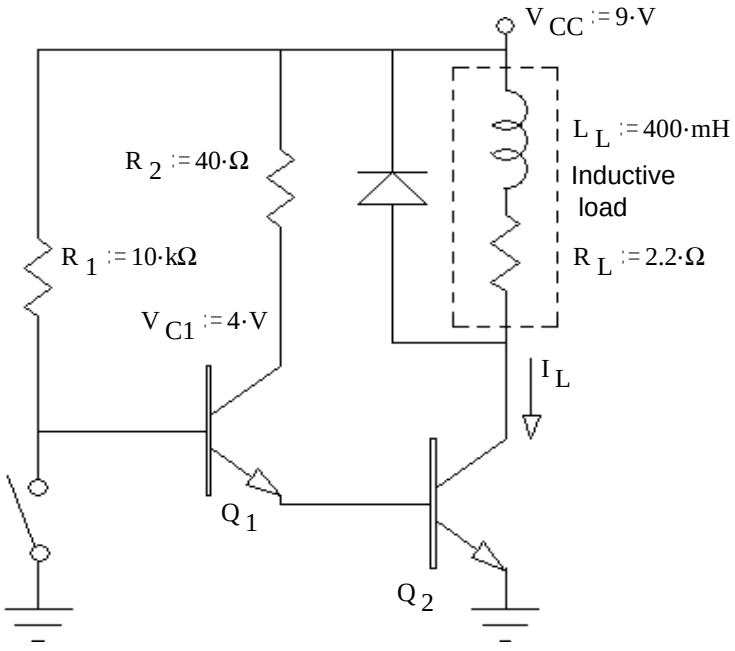


b)





9. (28 pts) A couple of transistors are used to control the current flow through an inductive load.



a) The switch has been open for a long time. You measure the voltage at the collector of Q_1 to be the value shown (referenced to ground). What is the minimum β_2 needed to insure that transistor Q_2 is in saturation? You may assume that the emitter current of Q_1 is approximately equal to the collector current of Q_1 . β_{2min} = ?

b) Find the power dissipated in transistor Q_2 with this β. P_{Q2} = ?

c) Find the β of Q_1. β_1 = ?

d) Is this a minimum, maximum, or actual value of β_1? (circle one)

e) Find the power dissipated in transistor Q_2 if $\beta_2 := 25$ P_{Q2} = ?

f) Find the power dissipated in transistor Q_2 if $\beta_2 := 25$ and the switch is closed. P_{Q2} = ?

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

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

h) 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 a).

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.

Answers

1. $2.75\cdot k\Omega$ $1.111\cdot k\Omega$ $27\cdot mA$

2. a) $20mA \angle -40^o = (15.321 - 12.856\cdot j)\cdot mA$ b) $(4.3 - 0.476\cdot j)\cdot V = 4.33V \angle -6.31^o$ c) $13.13mA \angle 48.6^o$

3. $30\cdot mA - 12\cdot mA\cdot e^{\frac{-t}{60\cdot \mu s}}$ c) $108\cdot \mu s$

4. a) $\dfrac{\frac{1}{L_m\cdot C}}{s^2 + \left(\frac{R_m}{L_m} + \frac{1}{R\cdot C}\right)\cdot s + \frac{1}{L_m\cdot C}\cdot\left(1 + \frac{R_m}{R}\right)}$ b) 2 c) 0

5. a) $396\cdot W$ b) $396\cdot W$ c) $3.3A \angle 0^o$

   d) $R := 24.74\cdot\Omega$ $L := 45\cdot mH$

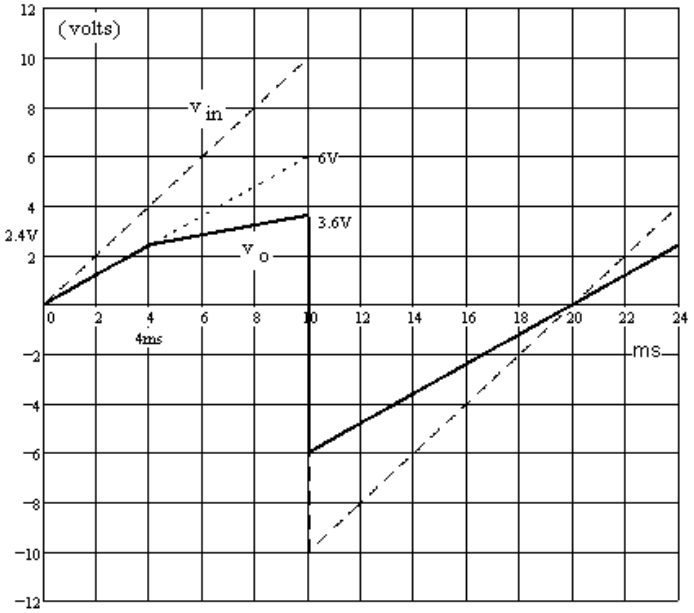
6. a) $1.3\cdot V$ $15\cdot mA$ $43\cdot mA$ $63\cdot mA$

   b) no $V_{D1} = 1.3\cdot V > 0.7V$

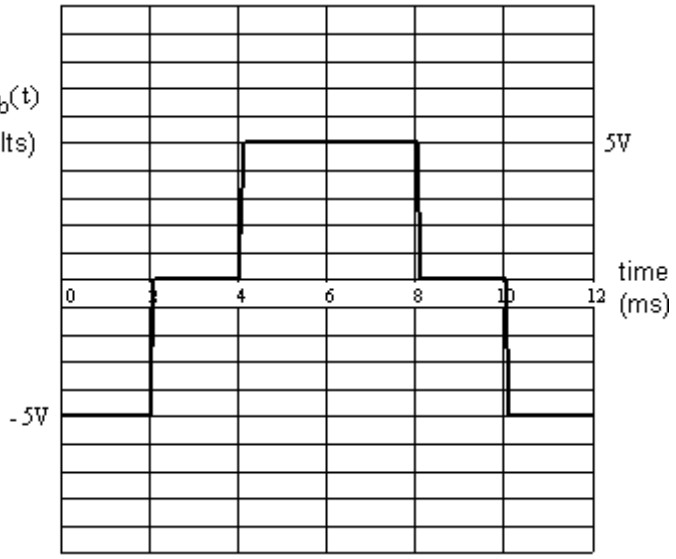
   c) yes $I_{D2} = 15\cdot mA > 0$

   d) yes $I_{D3} = 43\cdot mA > 0$

7.



8.



9. a) 32 b) $0.8\cdot W$ c) $0.76\cdot mA$ 164.5 d) actual

   e) $6.64\cdot W$ f) $0\cdot W$ g) B f) $4\cdot A$