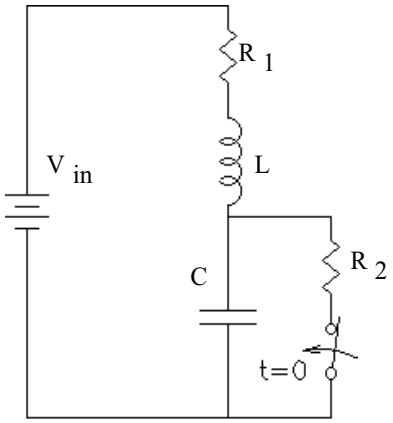
ECE1050 Final given: Fall 03

(The space between problems has been removed, & question 9 is out of order.)



1. (15 pts) Find the characteristic equation of the circuit shown. (after the switch closes at t = 0). Write your equation in the form of a simple polynomial.
   You MUST show work to get credit.

2. (13 pts)
   a) Find the solutions (numbers) of the following characteristic equation: $0 = s^2 + \frac{R}{L}\cdot s + \frac{1}{L\cdot C}$

   Where: $R := 50\cdot\Omega$ $L := 8\cdot mH$ $C := 0.2\cdot\mu F$

   b) This system represented by this characteristic equation is: (circle one)

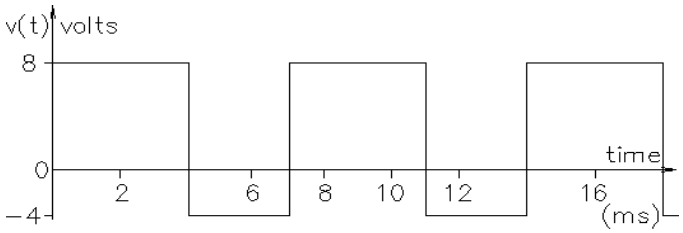
   i) underdamped ii) critically damped iii) overdamped iv) impossible to tell

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

3. (14 pts) For waveform shown, find:

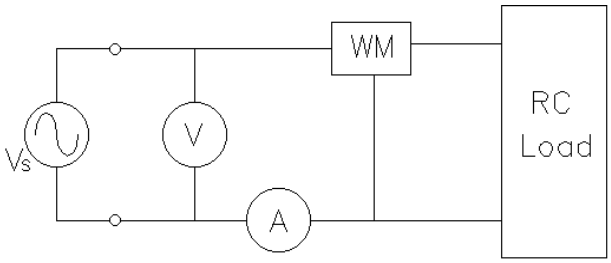
   a) Average DC (V_{DC}) value

   b) RMS (effective) value



4. (22 pts) For the 60 Hz load shown in the figure, the RMS voltmeter measures 240 V, the RMS ammeter measures 3 A, and the wattmeter measures 400 W. Find the following:

   $V_s := 240\cdot V$ $I := 3\cdot A$



   a) The real power. P = ?

   b) The apparent power. |S| = ?

   c) The reactive power. Q = ?

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

   e) The power factor. pf = ?

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

   g) The load box cannot be opened. Add (draw it) 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.

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5. (23 pts) In the circuit shown, use the constant-voltage-drop model for the silicon diode.

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

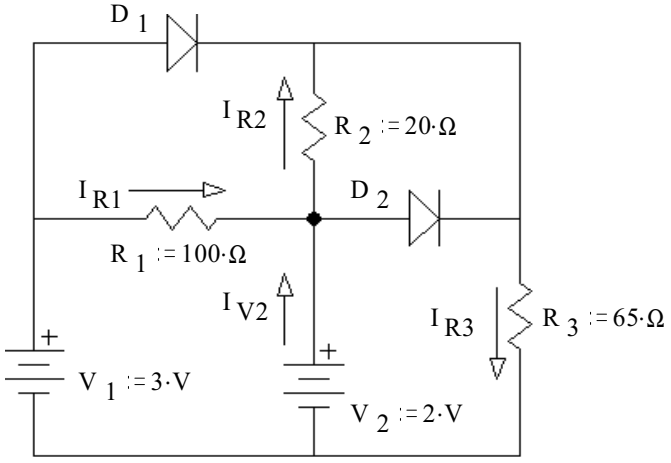
Find I_{R1}, I_{R2}, I_{R3}, I_{V2}, & based on these assumptions. Stick with these assumptions even if your answers come out absurd. Hint: think in nodal voltages.

I_{R1} = _____

I_{R2} = _____

I_{R3} = _____

I_{V2} = _____



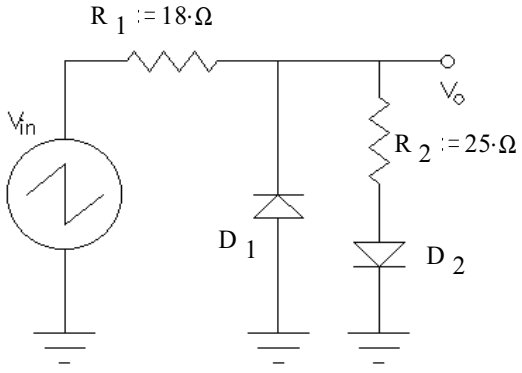
b) Based on your numbers above, does it look like the assumption about D_1 was correct? yes no (circle one)

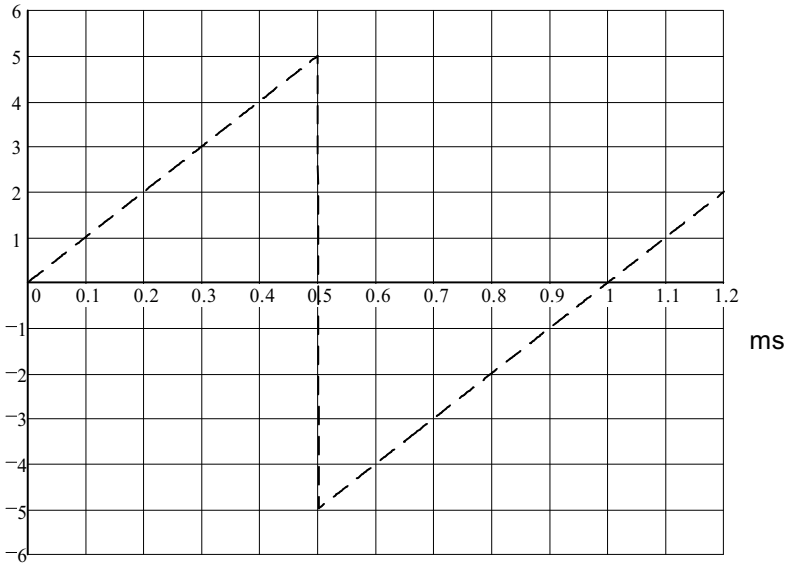
How do you know? (Specifically show a value which is or is not within a correct range.)

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.)

6. (18 pts) A voltage waveform (dotted line) is applied to the circuits shown. Accurately draw the output waveform (v_o) you expect to see. Label important times **and** voltage levels.





Answers (some)

1. $0 = s^2 + \left(\frac{1}{C \cdot R_2} + \frac{R_1}{L}\right) \cdot s + \left(1 + \frac{R_1}{R_2}\right) \cdot \frac{1}{L \cdot C}$

2. a) -3125 ± 24800j 1/sec b) i) underdamped c) 12.8μF

3. a) 2.86V b) 6.59V 4. a) 400W b) 720VA c) -599VAR d) (400 - 599j)VA e) 0.556 f) i) leading
g) Add a 255mH inductor in parallel with load

5. a) 10mA 35mA 20mA 10mA b) no, $V_{D1} > 0.7V$ b) no, $I_{D2} < 0$

6. Straight lines between the following points:
(0ms,0), (0.07ms,0.7V), (0.5ms,3.2V), (0.5ms,-0.7V), (0.93ms,-0.7V), (1.07ms,0.7V), (1.5ms,3.2V)

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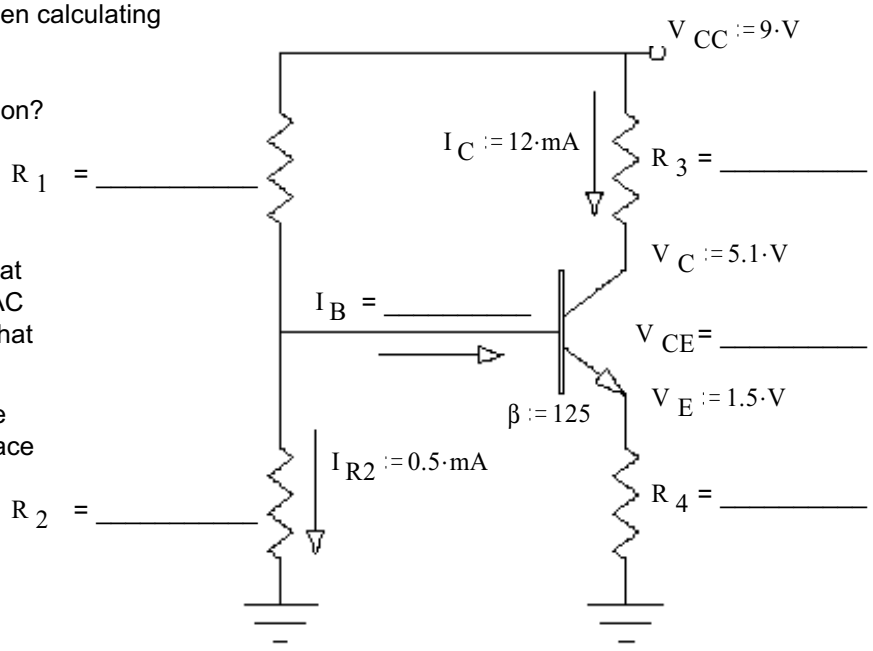
7. (30 pts) Fill in the blanks in the circuit. You may neglect I_B's contribution to I_E, but plese account for I_B when calculating resistor(s) connected to the base.



b) Is the transistor operating in the active region?

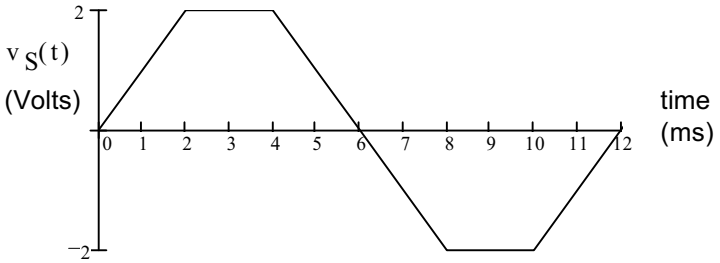
Yes No Show your evidence.
(circle one)

c) If the some components were added so that you could add an AC signal at the base, an AC signal would also appear at the collector. What signal gain do you expect to see?

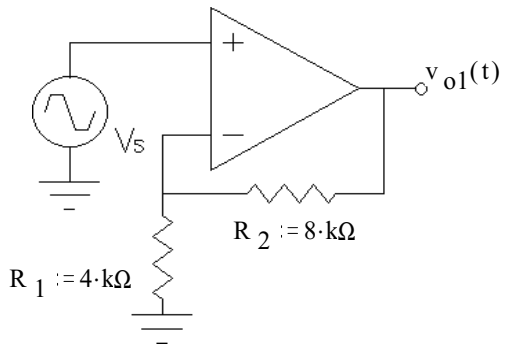
d) How could you improve this gain? Add the appropriate component in the appropriate place in the circuit above.

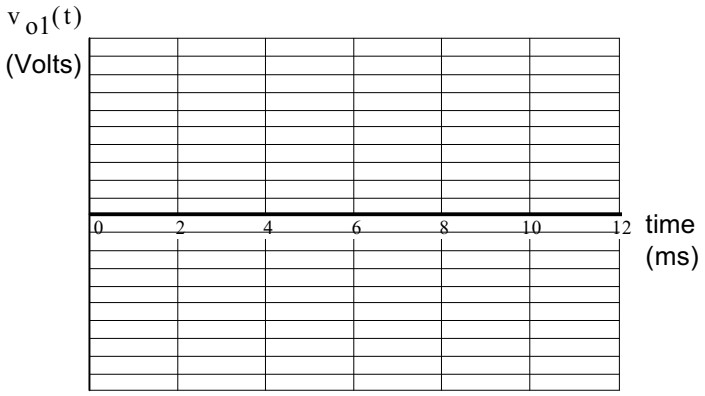
e) Compare I_B to I_{R2}. Would it have been reasonable to neglect I_B?
(is I_B < 10% of I_{R2}) Yes No
(circle one)

7. (33 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. The op-amp is connected to +15V & -15V power supplies.

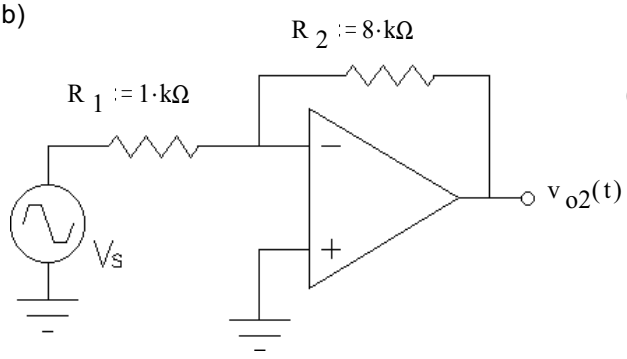


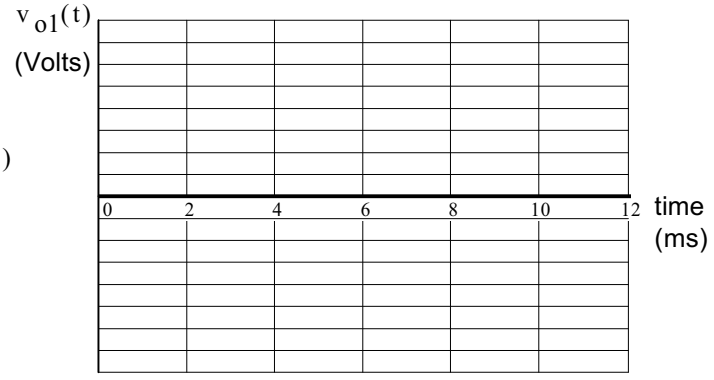
a)





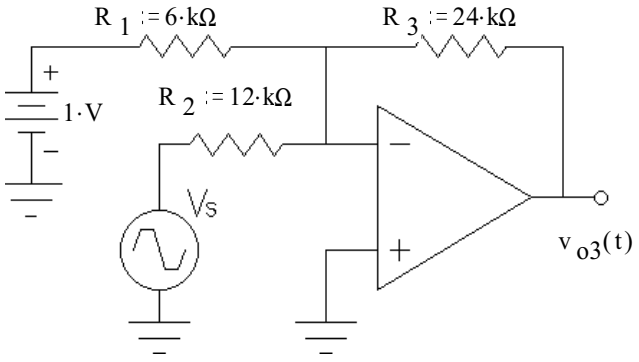
b)

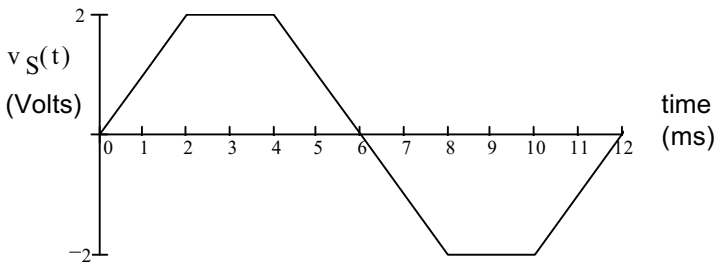


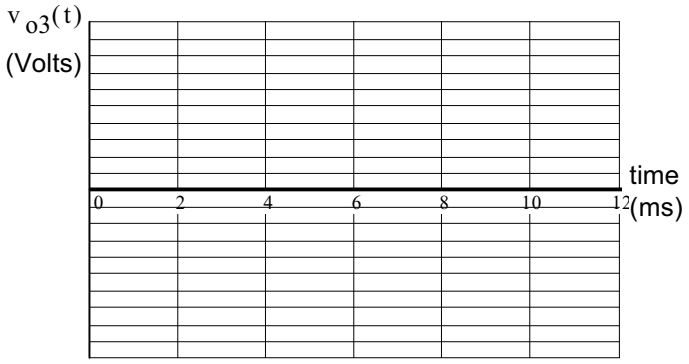


8. continued, the input is repeated at right

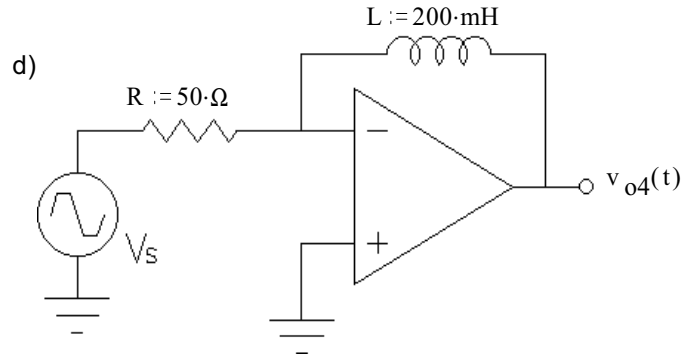
c)

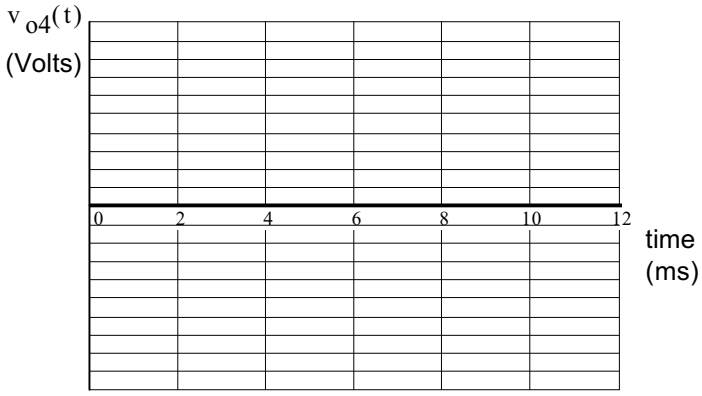






d)



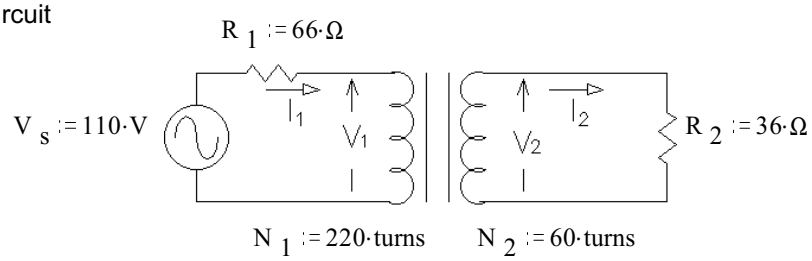


hint: use the answers provided with the last HW.

9. (12 pts) The transformer shown in the circuit below is ideal. Find the following:

a) I_1 = ?

b) I_2 = ?



10. 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 or an excel spreadsheet which you can download. Both will show all your homework, lab, and exam scores.

Answers

7. a) $R_1 = 11.4k\Omega$, $R_2 = 4.4k\Omega$, $I_B = 0.1mA$, $R_3 = 325\Omega$, $V_{CE} = 3.6V$, $R_4 = 124\Omega$ b) yes, $V_{CE} > 0.2V$ c) 2.62

d) Place a capacitor in parallel with R_4. e) no, $I_B > 10\% I_{R2}$

8. a) Straight lines between the following points: (0ms,0), (2ms, 6V), (4ms, 6V), (8ms, -6V), (10ms, -6V) & (12ms, 0V)

b) Straight lines between the following points: (0ms,0), (1.75ms, -14V), (4.25ms, -14V), (7.75ms, 14V), (10.25ms, 14V) & (12ms, 0V)

c) Straight lines between the following points: (0ms,-4), (2ms, -8V), (4ms, -8V), (8ms, 0V), (10ms, 0V) & (12ms, -4V)

d) Straight lines between the following points: (0ms,-4), (2ms, -4V), (2ms, 0V), (4ms, 0V), (4ms, 4V), (8ms, 4V), (8ms, 0V), (10ms, 0V) (10ms, -4V) & (12ms, -4V) Extra credit if you show slew effects.

9. a) 0.2A b) 0.733A