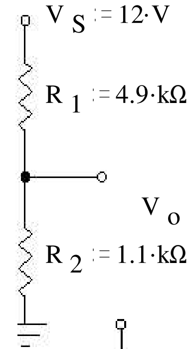
EE1050 Final given: Fall 01

(The space between problems has been removed.)

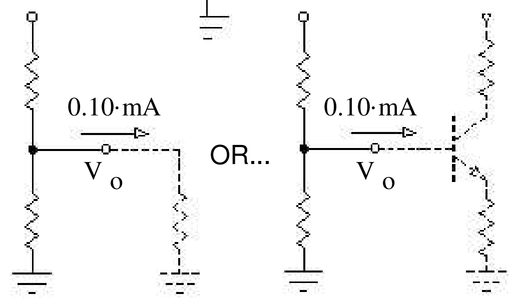
1. (18 pts)

   a) Find and draw the Thévenin equivalent of the circuit shown. V_S represents a +DC power source (just like those you're used to seeing in transistor and op-amp circuits). If it helps you, draw a 12 V battery connected from ground to the V_S. The load resistor is not shown, but would be hooked between V_O and ground.

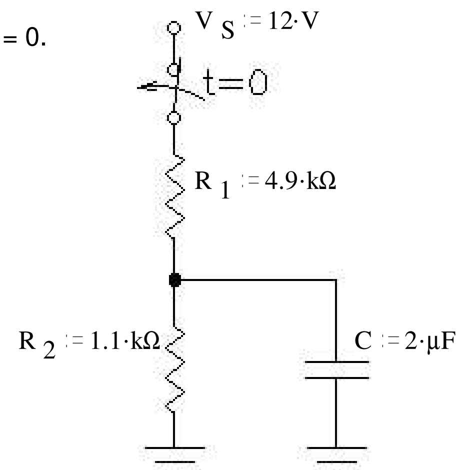


   b) Find and draw the Norton equivalent of the same circuit.

   c) A load of some sort is connected to the circuit above, it could be a simple resistor, or it could be a transistor circuit, or whatever. It draws a current of 0.1mA, what is the value of V_O now?



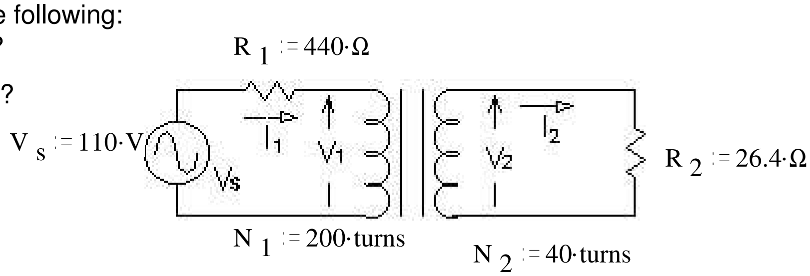
2. (11 pts) The switch has been open for a long time and is closed at time t = 0. Find the complete time expression of $V_C(t)$.
   V_S represents a +DC power source (just like problem 1).



3. (11 pts) The transformer shown in the circuit below is ideal.
   Find the following:

   a) I_1 = ?

   b) V_2 = ?



4. (20 pts) To get partial credit, show each step and each answer along the way.

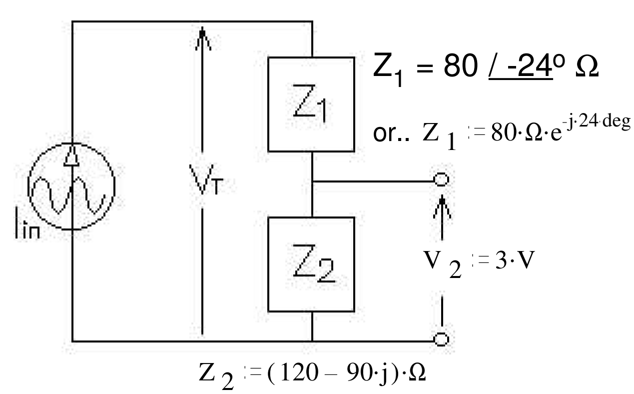
   a) Find I_{in} in polar form.

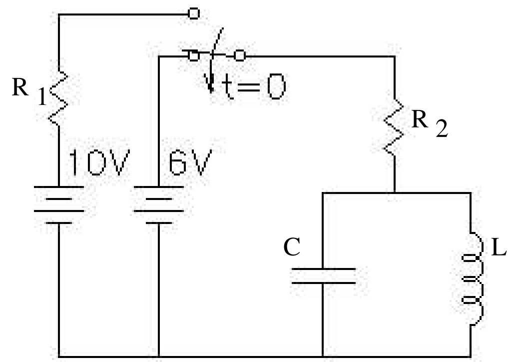
   b) Find V_T.

   c) $Z_1 + Z_2$ together are the load. What is the power factor of this load? pf = ?
   Hint: use the phase angles of I_{in} and V_T to find this.

   d) Circle 1: i) The power factor is leading
   (source current leads the source voltage)

   ii) The power factor is lagging
   (source current lags the source voltage)





5. (18 pts) a) Find the characteristic equation of the circuit shown (after the switch moves to the lower position at t = 0). You <u>MUST</u> show work to get credit.

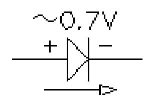
   b) Find the solutions of the characteristic equation given these component values.

   $R_1 := 25\cdot\Omega$ $R_2 := 125\cdot\Omega$ $L := 5\cdot mH$ $C := 0.08\cdot\mu F$

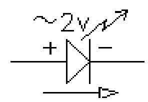
   c) This circuit is: (circle one) i) underdamped

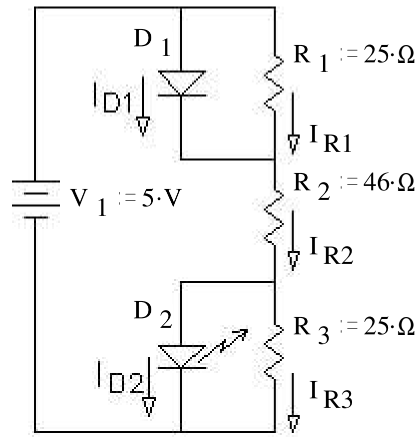
   ii) critically damped iii) overdamped iv) can't tell

6. (22 pts) Assume the diodes are silicon with a 0.7V forward voltage drop:



Assume the LEDs have a 2V forward voltage drop:





   a) Assume that diode D_1 and diode D_2 <u>both</u> conduct.

   Find I_{R1}, I_{R2}, I_{R3}, I_{D1}, and I_{D2} based on these assumptions.

   I_{R1} = __________

   I_{R2} = __________

   I_{R3} = __________

   I_{D1} = __________

   I_{D2} = __________

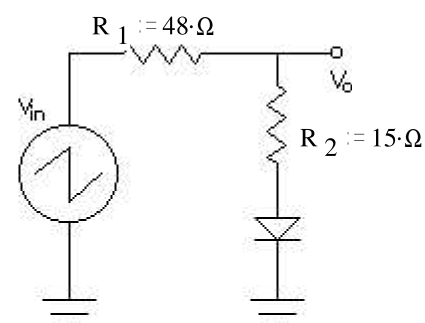
   b) Was the assumption about D_1 correct? yes no (circle one)

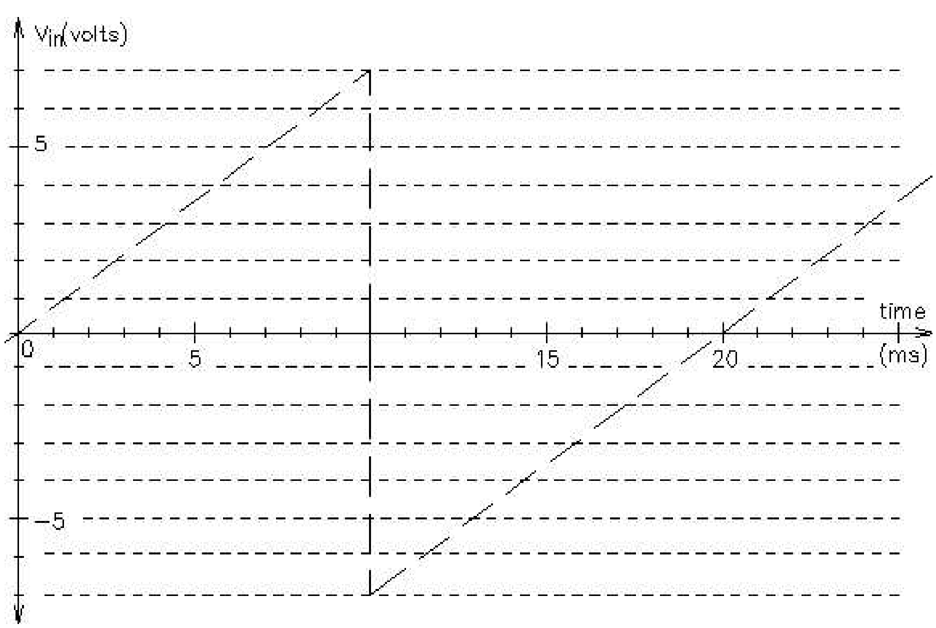
   How do you know?

   c) Was the assumption about D_2 correct? yes no (circle one)

   How do you know?

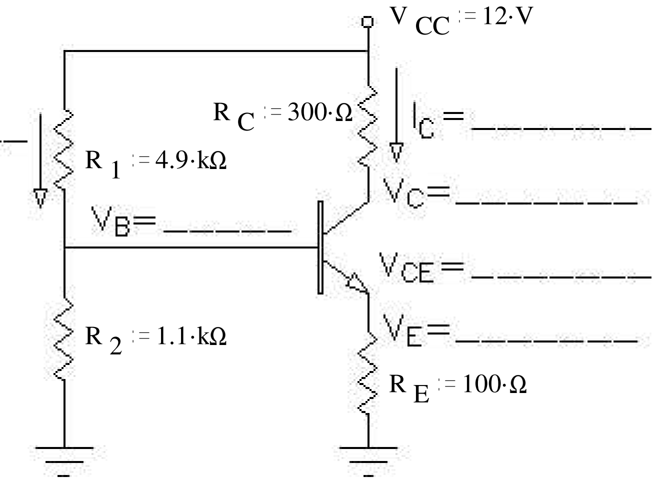
7. (16 pts) The input voltage to the circuit at right is shown below (dotted line). Accurately draw the output voltage you expect to see across R_2 and the the diode. Label the important voltages **<u>and</u>** times





8. (36 pts) Fill in the blanks in the circuit.
You may neglect I_B (assume that it's 0).

I_{R1} = ________



b) Is the transistor operating in the active region?

(circle one) Yes No

Show your evidence.

c) If R_C is too big the transistor will no longer be in its active region and will saturate. What value of R_C just begins to cause saturation? Hint: Assume V_{CE} = 0.2V and find the R_C that would cause that.

d) $\beta := 150$ Use the value of I_C that you calculated above to approximate the value of I_B (previously neglected).

e) Compare this value to I_{R1}. Was it reasonable to neglect I_B? (is I_B < 10% of I_{R1}) Yes No (circle one)

f) If the I_B from part d were correct, would V_B be lower, higher or the same as you found earlier?

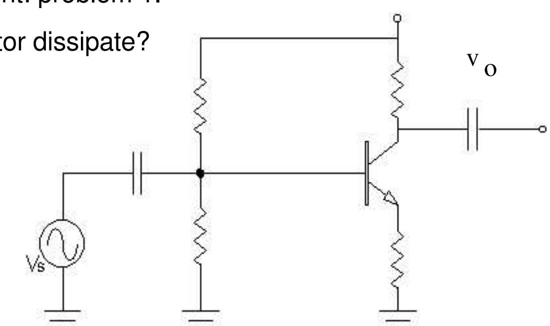
(circle one) V_B would be: lower higher same

g) (4 pts extra credit) If the I_B from part d were correct, find V_B. Hint: problem 1.

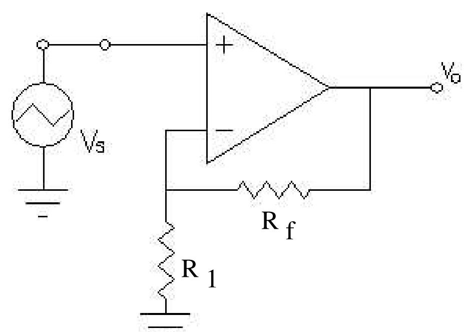
h) Considering only I_C and V_{CE}, how much power does this transistor dissipate?

i) 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?

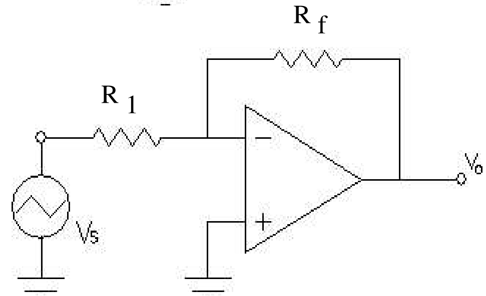
$$\frac{v_o}{v_s} = ?$$



9. (8 pts) Design an amplifier with a gain of 10. The output voltage must be in phase with the input voltage (no inversion is allowed). Draw the circuit and show the values you would use.

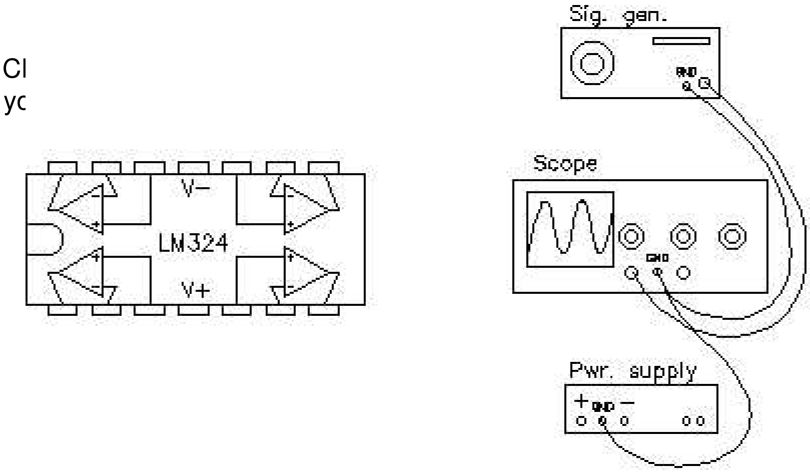


10. (8 pts) Design an amplifier with a gain of 15. The output voltage should be 180 out of phase with the input voltage (inversion is required). Its input resistance must be <u>greater</u> than 10 kΩ. That is, from the input's point of view, the amplifier should look like <u>more</u> than a 10 kΩ resistor hooked to ground.



11. (10 pts) You want to make the amplifier of problem 10 in the lab, using a LM324 op-amp. (Yes, you must have an answer for problem 10, make a guess if you don' t know but include at least two components besides the op-amp in your guess.)

Show parts with values (may be shown as schematic symbols).
Show power supply connections. (You don' t need to show extra power supply filter capacitors.)
Show all ground connections.
Show signal input connection(s).
Show scope connection(s) to observe the output on Cl
Crossing wires will not be assumed to connect unless yc show a dot at the crossing. I have shown CH1 scope connections to the signal generator as an example.



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

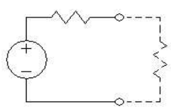
If your answer is yes, then provide some sort of alias or password: ______________________________

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

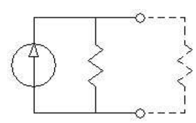
Answers

1.a) $R_{Th} := 898\cdot\Omega$ b) $R_N := 898\cdot\Omega$ c) 2.11V

$V_{Th} := 2.2\cdot V$



$I_N := 2.45\cdot mA$



2. $2.2\cdot V - 2.2\cdot V\cdot e^{-\frac{t}{1.8\cdot ms}}$

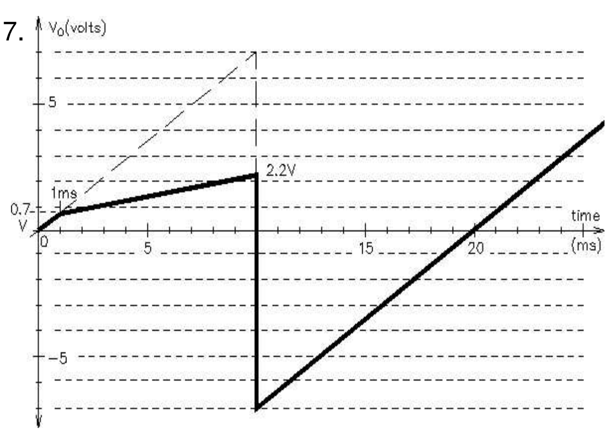
3. a) 0.1A b) 13.2V

4. a) I_{in} = 20mA / 36.9° b) V_T = 4.57V / 4.47° c) 0.844 d) ii, leading, angle of V_T is greater than I_{in}

5. a) $0 = s^2 + \frac{1}{R_2\cdot C}\cdot s + \frac{1}{L\cdot C}$ b) -50,000 1/sec c) ii, critically damped

6. a) 28mA 50mA 80mA 22mA -30mA b) yes, I_{D1} = 22mA > 0 c) no, I_{D2} = -30mA < 0

7.



8. a) V_B = 2.2V I_{R1} = 2mA V_E = 1.5V $I_C \simeq I_E$ = 15mA
V_C = 7.5V V_{CE} = 6V b) yes, V_{CE} = 6V > 0.2V
c) 687Ω d) 0.1mA e) I_B = 5%I_{R1}, yes f) lower
g) 2.11V h) 90mW i) 3

9. R_1 = any value from 100Ω to 110kΩ
R_f is 9 times bigger ($R_f = 9R_1$).

10. R_1 = any value from 11kΩ to 66kΩ
R_f is 15 times bigger ($R_f = 15R_1$).

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