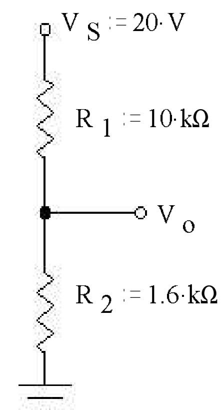
EE1050 Final given: Spring 02

(The space between problems has been removed.)

1. (18 pts)

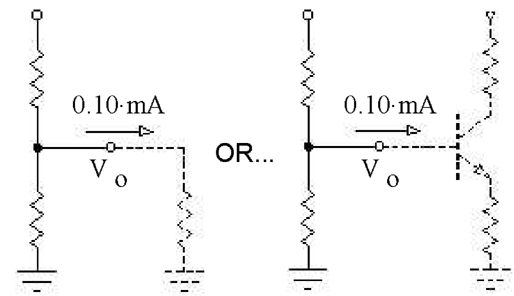
a) Find and draw the Thévenin equivalent of the circuit shown. V_S represents a +DC power source (just like those you're used to seeing in transistor and op-amp circuits). If it helps you, draw a 20 V battery connected from ground to the V_S. The load resistor is not shown, but would be hooked between V_O and ground.



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

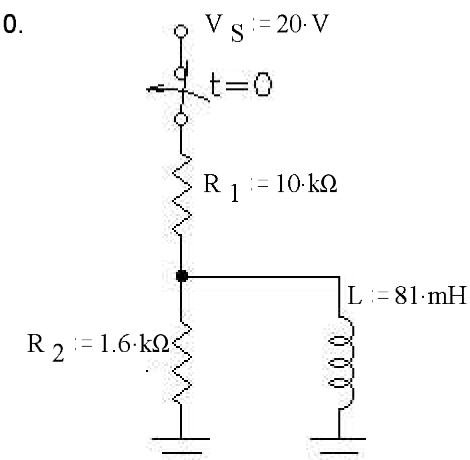
c) A load of some sort is connected to the circuit above, it could be a simple resistor, or it could be a transistor circuit, or whatever. It draws a current of 0.1mA, what is the value of V_O now?

$I_o := 0.10 \cdot mA$



2. (13 pts) The switch has been open for a long time and is closed at time t = 0. Find the complete time expression of $V_L(t)$.

V_S represents a +DC power source (just like problem 1).

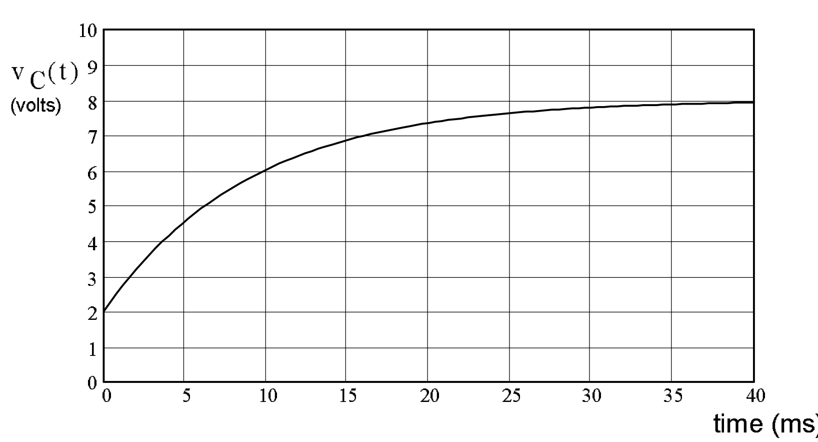


3. (13 pts) The capacitor voltage of a simple RC circuit is shown below.

a) What was the initial voltage across the capacitor?

b) What is the DC source voltage of this RC circuit?

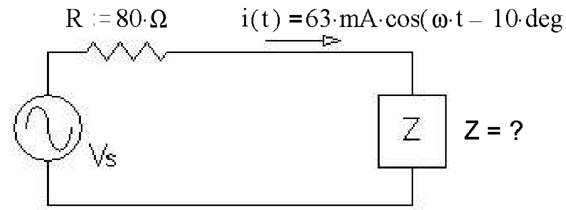
c) What is the time constant



4. (26 pts) a) Find Z.

$v_S(t) = 10 \cdot V \cdot \cos(\omega \cdot t + 30 \cdot deg)$

$\omega := 377$



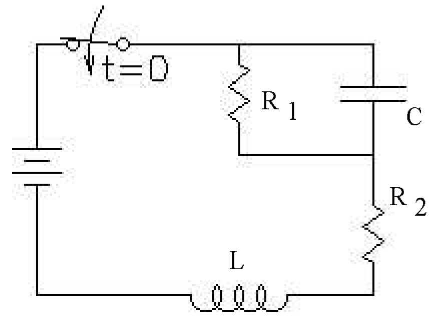
b) Circle 1: i) The current leads the voltage ii) The voltage leads the current

c) By how much? I.E. what is the phase angle between the voltage and current?

d) What is the power factor of this circuit? (as seen by V_S)

e) How much average power does V_S supply to the circuit? Note: v_s is NOT given in RMS.

5. (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 <u>MUST</u> show work to get credit.



6. (18 pts)
a) Find the solutions (numbers) of the following characteristic equation: $0 = s^2 + \left(\frac{1}{C \cdot R_1} + \frac{R_2}{L}\right) \cdot s + \frac{1}{L \cdot C}$

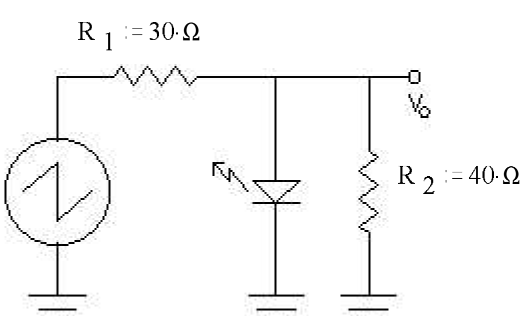
Where: $R_1 := 1000 \cdot \Omega$ $R_2 := 2000 \cdot \Omega$ $L := 8 \cdot mH$ $C := 0.1 \cdot \mu F$

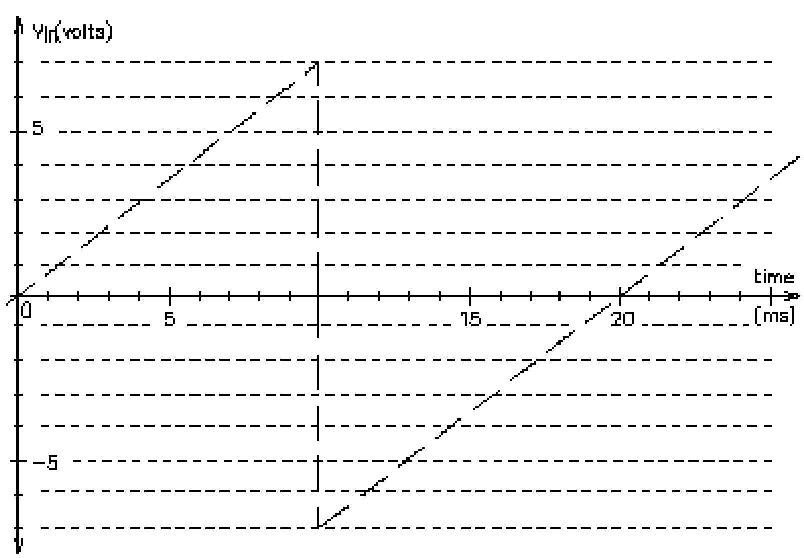
b) This system represented by this characteristic equation is: (circle one)

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

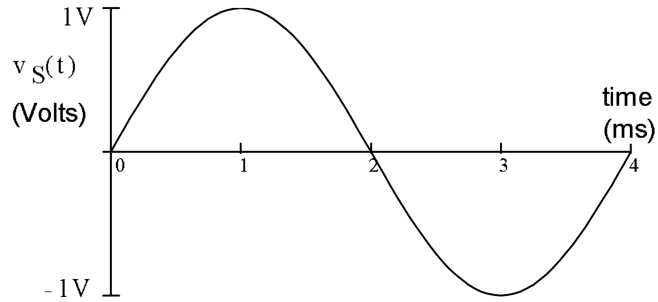
c) What value of R_2 would make this system critically damped?

7. (16 pts) A voltage waveform (dotted line) is applied to the circuit shown. <u>Accurately</u> draw the output waveform (v_o) you expect to see. Use the constant-voltage-drop model for LED. Label important times and/or voltage levels.

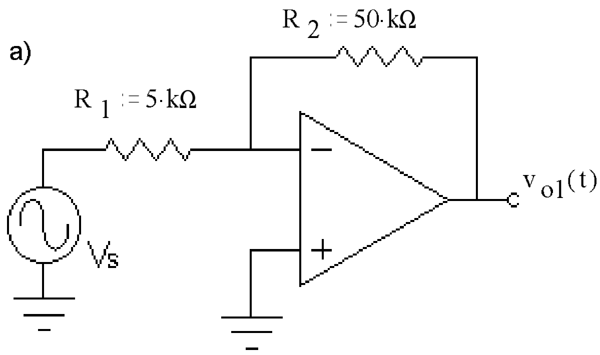


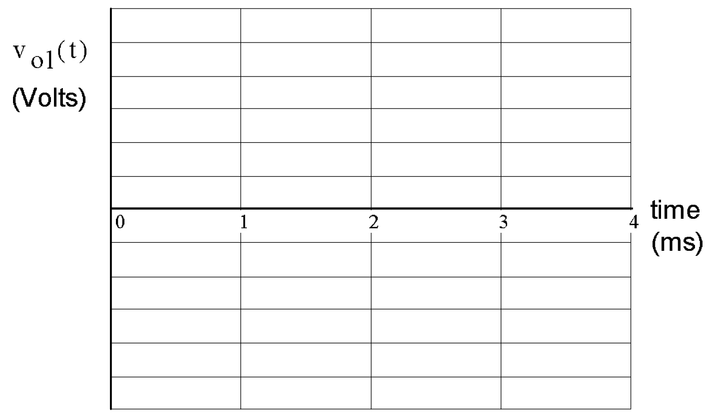


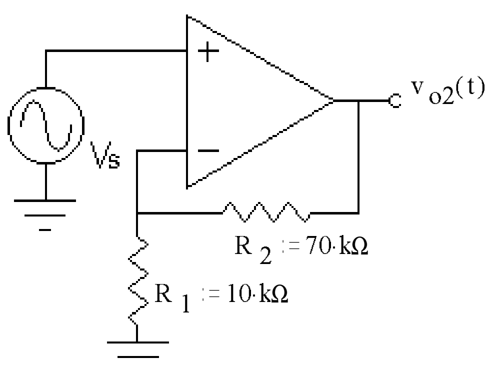
8. (27 pts)The same input signal (at right) is connected to several opamp circuits below. Sketch the output waveform for each circuit. Clearly label important voltage levels on each output. If I can't easily make out what your peak values are, I'll assume you don't know. Don't forget to show inversions.

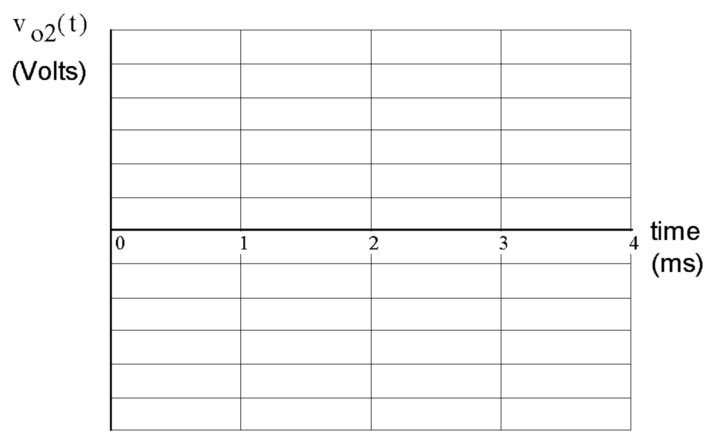


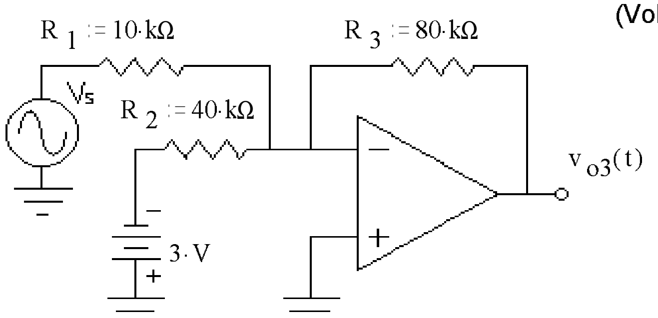
a)

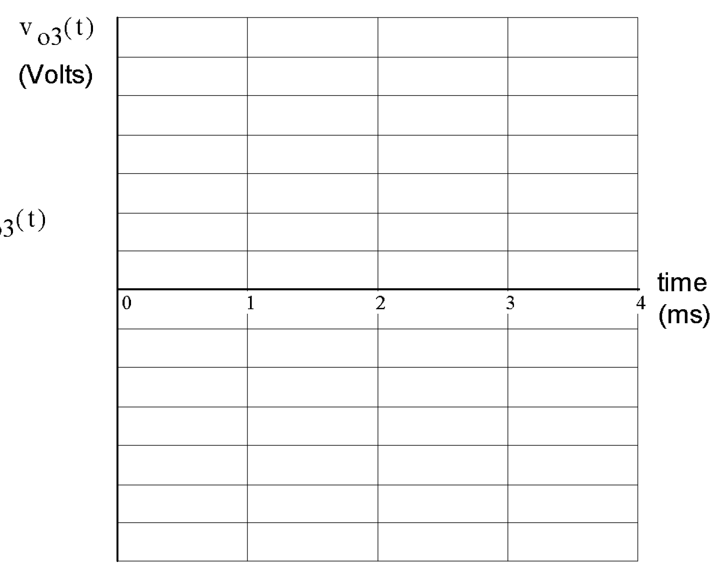




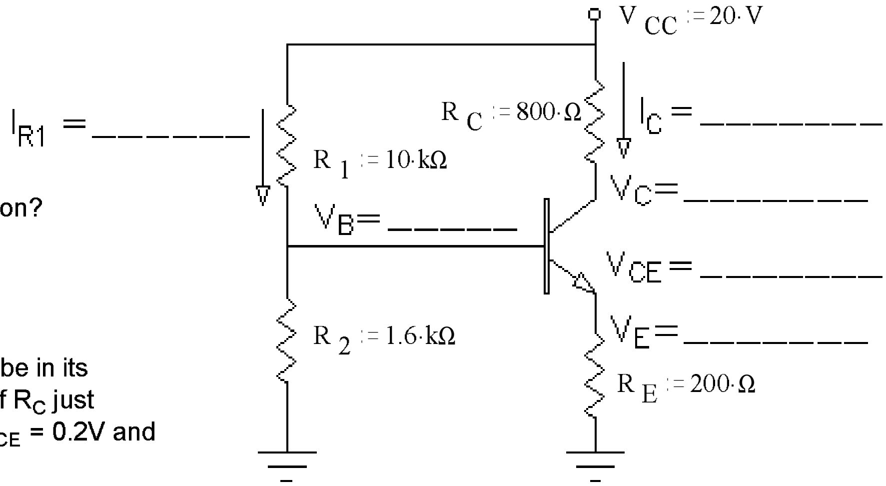








9. (34 pts) Fill in the blanks in the circuit.
   You may neglect I_B (assume that it's 0).



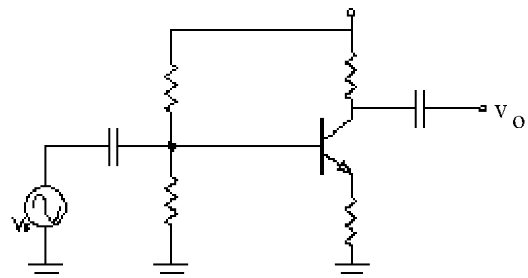
b) Is the transistor operating in the active region? Show your evidence.

Yes No
(circle one)

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) 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?

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



e) $\beta := 103$ Use the value of I_C that you calculated above to approximate the value of I_B (previously neglected).

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

g) (3 pts extra credit) If the I_B from part e were correct, find V_B. Hint: problem 1.

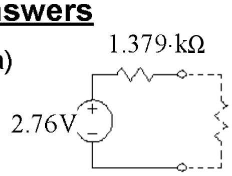
10. Do you want your grade and scores posted on my door and on the internet? Yes No (Circle one)

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

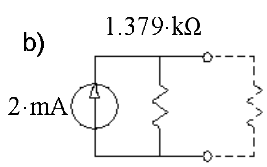
The grades will be posted on my door in alphabetical order under the alias that you provide here. I will not post grades under your real name. The internet version will be an excel spreadsheet which you can download. Both will show all your homework, lab, and exam scores.

Answers

1. a)



b)



c) 2.621V

2. $2.76 \cdot V \cdot e^{-\frac{t}{58.7 \cdot \mu s}}$

3. a) 2V b) 8V c) 9.1ms

4. a) 41.6Ω + 102jΩ b) ii c) 40° d) 0.766 e) 0.241W

5. $0 = s^2 + \left(\frac{1}{C \cdot R_1} + \frac{R_2}{L}\right) \cdot s + \left(1 + \frac{R_2}{R_1}\right) \cdot \frac{1}{L \cdot C}$

6. a) $s_1 := -4.9 \cdot 10^3 \cdot \frac{1}{sec}$ $s_2 := -2.551 \cdot 10^5 \cdot \frac{1}{sec}$

   b) iii) overdamped c) 486Ω

7. Straight lines between the following points: (0ms,0V), (10ms,2V), (10ms,-4V), (25ms,2V), (26ms,2V)

8. a) 20Vpp sine wave, inverted, -10V peak, +10V peak b) 16Vpp sine wave, not inverted, 8V peak, -8V peak
   c) 16Vpp sine wave, inverted & DC shifted up by 6V, -2V peak, +14V peak

9. a) V_B = 2.759V, I_{R1} = 1.724mA, V_E = 2.059V, I_E = 10.29mA ≃ I_C, V_C = 11.77V, V_{CE} = 9.71V
   b) yes, V_{CE} = 9.71V > 0.2V c) 2kΩ d) 4 e) 0.1mA f) yes, I_B = 5.8% I_C g) From problem 1: 2.62V