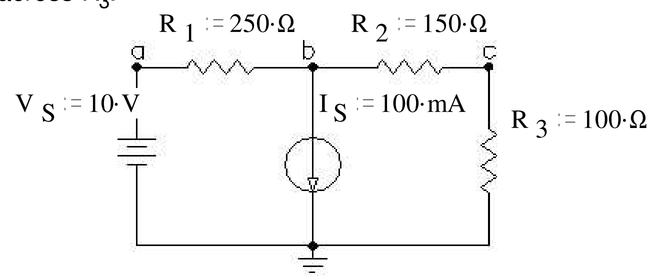
EE1050 Final given: Fall 00

(The space between problems has been removed.)

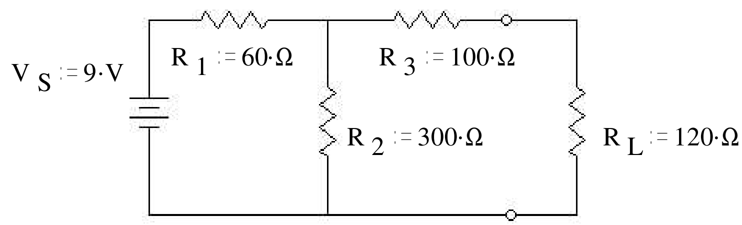
1. (16 pts) Use the method of superposition to find V_c, the voltage across R_3. Be sure to clearly show and circle your intermediate results.



2. (12 pts) If you wanted to solve the problem above using nodal analysis, you would have to write one or more nodal equations. Write all the necessary equation(s) in terms of the resistors, the sources, and the unknown nodes. Just write and circle the equations, do not try to simplify or solve them. Don't panic, this is an easy problem and it has more than one right answer.

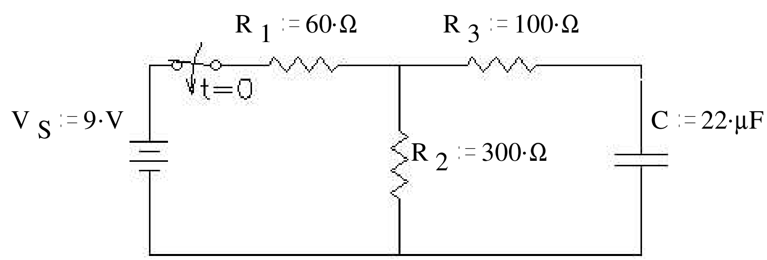
3. (18 pts) a) Find and draw the Thévenin equivalent of the circuit shown. The load resistor is R_L.

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

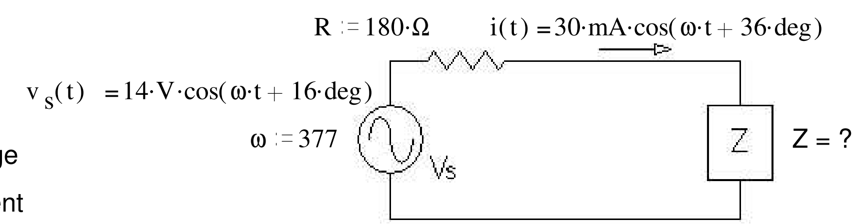


4. (8 pts) a) What is the time constant of this circuit? Hint: notice the similarity to the circuit above.

   b) What will be the final value of v_C? (After the switch has been closed for a long time)



5. (26 pts) a) Find Z.



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

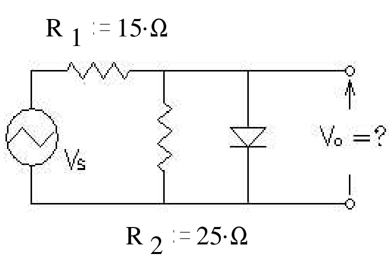
   ii) The voltage leads the current

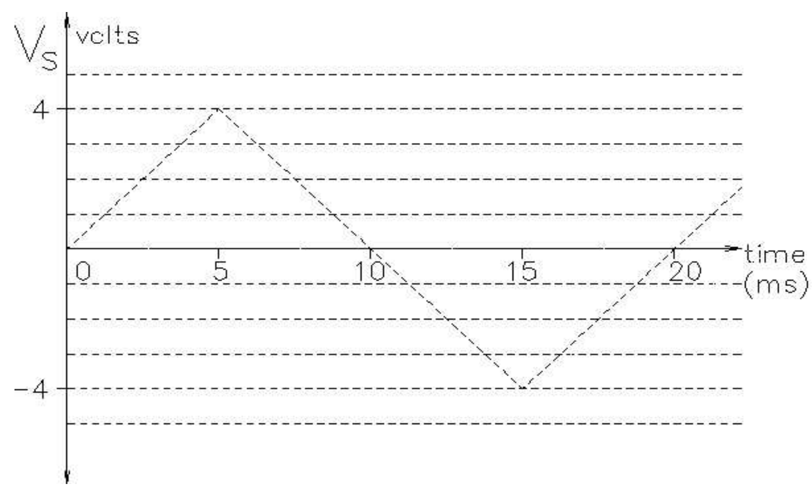
   c) By how much? I.E. what is the phase angle between the voltage and current?

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

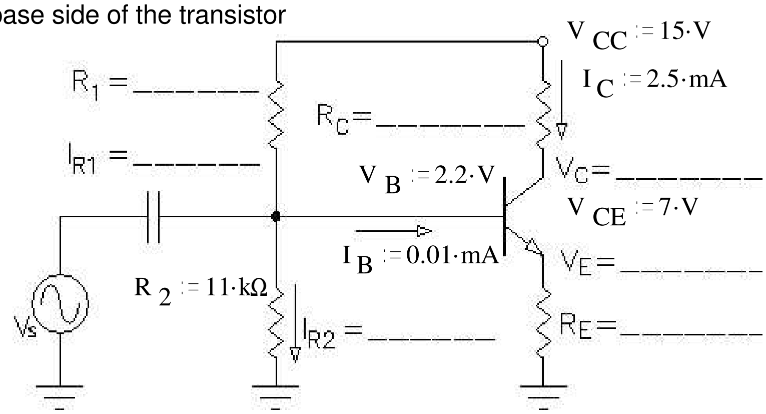
   e) How much average power does V_S supply to the circuit?

6. (15 pts) The input voltage to the circuit below is shown at right (dotted line). Show the output voltage across the diode. Make it accurate and label the important voltages **and** times





7. (30 pts) Fill in the blanks in the circuit. You may neglect I_B's effect on I_E, but do not neglect it on the base side of the transistor



b) Is the transistor operating in the active region? Show your evidence. Yes No

c) What is the value of β for this transistor?

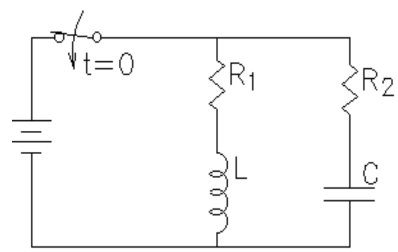
d) If we neglect I_B and use the values of R_1 and R_2 above to calculate V_B, what do you get?

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

f) If the v_s signal were applied at the base, an AC signal would also appear at the collector. How much larger would it be. (Voltage gain).

8. **OUT OF ORDER**, Problem 8 is shown on last page

9. (14 pts) Find the characteristic equation of the circuit at right.



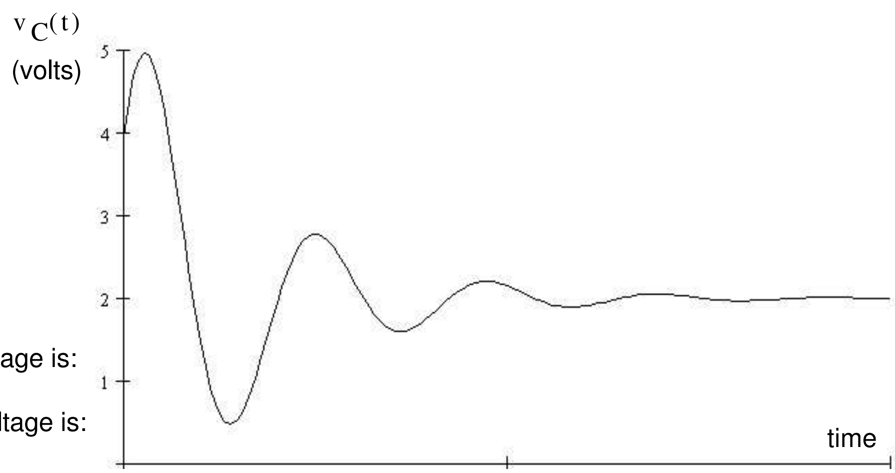
10. (9 pts) A circuit has the following characteristic equation:

$$s^2 + \left(\frac{R_1}{L}\right) \cdot s + \left(\frac{R_1}{R_2 \cdot L \cdot C}\right) = 0 \qquad R_1 := 50 \cdot \Omega \qquad L := 20 \cdot mH \qquad C := 40 \cdot \mu F$$

a) For what value of R_2 is the circuit critically damped?

b) To make the circuit overdamped, the value of R_2 should be: (circle one) i) Larger ii) Smaller

11. (10 pts) Consider the following transient waveform.



a) This circuit is: (circle one)
   i) underdamped
   ii) critically damped
   iii) overdamped
   iv) can't tell

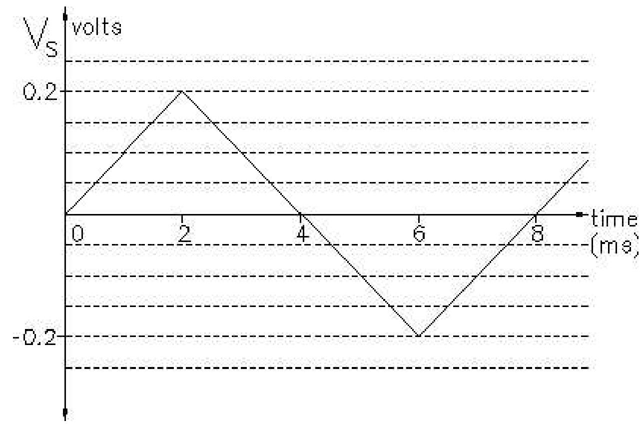
b) The final value of the capacitor voltage is:

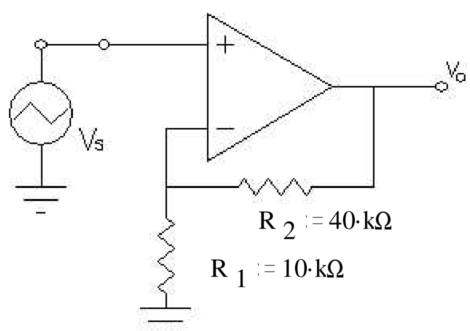
c) The initial value of the capacitor voltage is:

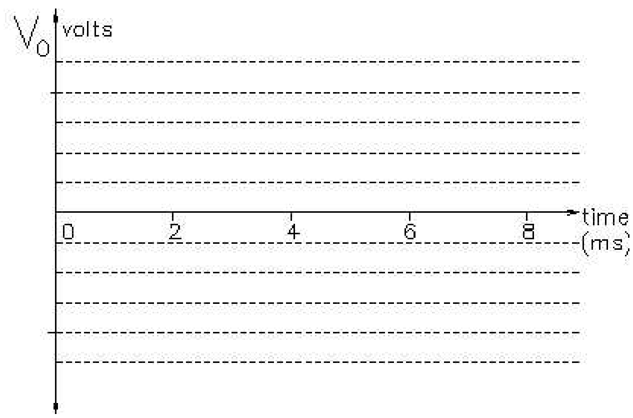
d) The initial current through the capacitor is: (circle one)

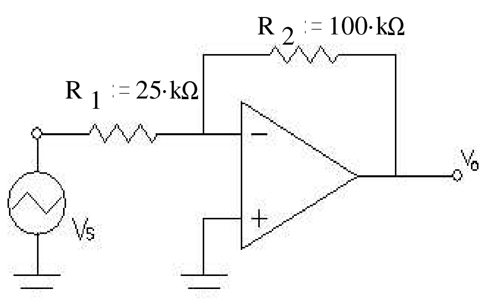
i) positive (+) ii) zero (0) iii) negative (-) iv) can't tell

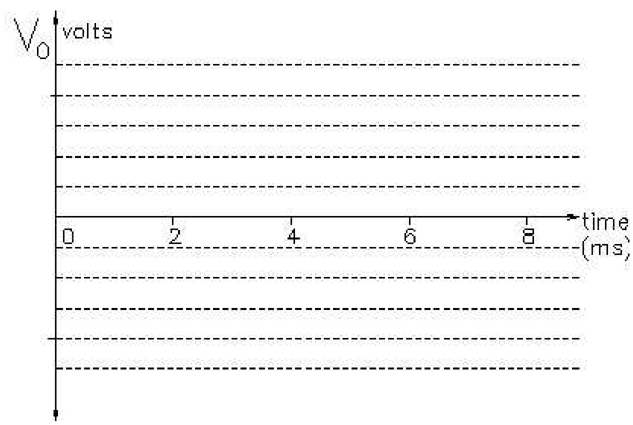
8. (20 pts)The same input signal is connected to several opamp circuits below. Sketch the output waveform for each circuit. Clearly label important voltage levels on each output. If I can' t easily make out what your peak values are, I' ll assume you don' t know.

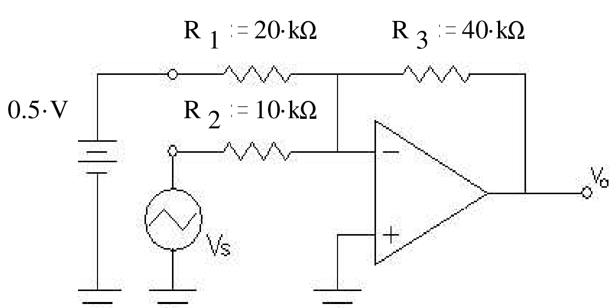


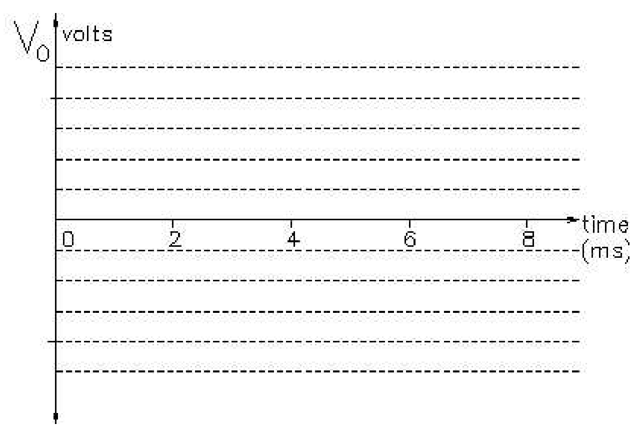












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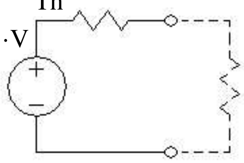
<u>Answers</u>

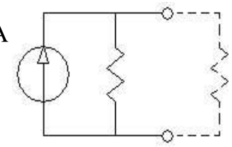
1. $V_{c.Is} := 2\cdot V$ $V_{c.Is} := -5\cdot V$ $V_c := -3\cdot V$

2. node a: $V_a = 10\cdot V$ This equation really isn't necessary node b: $\dfrac{V_S - V_b}{R_1} = \dfrac{V_b - V_c}{R_2} + I_S$ node c: $\dfrac{V_b - V_c}{R_2} = \dfrac{V_c}{R_3}$

3. a) $R_{Th} := 150\cdot\Omega$ $V_{Th} := 7.5\cdot V$



b) $R_N = R_{Th} = 150\cdot\Omega$ $I_N = \dfrac{V_{Th}}{R_{Th}} = 50\cdot mA$



4. a) $\tau := R_{Th}\cdot C$ $\tau := 3.3\cdot ms$ b) $v_C(\infty) = V_{Th} = 7.5\cdot V$

5. a) $Z := (259 - 160\cdot j)\cdot\Omega$ b) i c) $20\cdot deg$ d) 0.94 e) $0.197\cdot watt$

6. 0,0 1.4ms, 0.7V 8.6ms, 0.7V 15ms, -2.5V

7. a) $I_{R2} := 020\cdot mA$ $I_{R1} := 0.21\cdot mA$ $R_1 := 61\cdot k\Omega$ $V_E := 1.5\cdot V$ $R_E := 598\cdot\Omega$ $V_C := 8.5\cdot V$ $R_C := 2.6\cdot k\Omega$
   b) Yes, $V_{CE} := 7\cdot V > 0.2\cdot V$ c) 250 d) $2.293\cdot V$ e) $17.5\cdot mW$ f) 4.33

8. a) 0,0 2ms, 1V 6ms, -1V 8ms, 0V b) 0,0 2ms, -0.8V 6ms, 0.8V 8ms, 0V
   c) 0, -0.2V 2ms, -1.8V 6ms, -0.2V 8ms, -1V

10. a) $40\cdot\Omega$ b) larger 11. a) i b) $2\cdot V$ c) $4\cdot V$ d) i 9. $s^2 + \left(\dfrac{1}{C\cdot R_2} + \dfrac{R_1}{L}\right)\cdot s + \dfrac{R_1}{C\cdot R_2\cdot L} = 0$

<u>NOTE</u>

By the way, if you'll look at the circuit more closely, you'll see that it can easily be separated into two completely separate first order circuits. This means that while the characteristic equation for the total current is indeed a second order equation, it must always have two real roots (first order circuits can't ring). Sure enough, it turns out that this characteristic equation can be factored as below:

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

This results in the two roots: $s = -\dfrac{R_1}{L}$ and $s = -\dfrac{1}{C\cdot R_2}$

Which, if you think about it, is pretty predictable. If you saw this and mentioned it, you could get get some extra points.